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OBSERVATION OF THE SOLAR ECLIPSE CARRIED ON BY THE ASTROPHYSICAL OBSERVATORY, SMITHSONIAN INSTITUTION.*

THE use of the special apparatus already belonging to the Observatory, the very generous offer by Prof. E. C. Pickering, the director of the Harvard College Observatory, of the loan of the new 12-inch lens of 135 feet focus belonging to the Harvard College Observatory, and of several other valuable pieces of optical apparatus, together with loans of a 5-inch lens of 38 feet focus by Princeton University, and of a 5-inch equatorial by the Naval Observatory, enabled the expedition to take larger proportions than the modest appropriation might otherwise have justified.

This apparatus with many other adjuncts was temporarily installed in Washington in in the Smithsonian grounds and placed in the position each piece would occupy in the actual eclipse. This was with the view of familiarizing the observers with them, by successive rehearsals, which went on with assiduous practice during two months before all was taken down for shipment to the proposed site.

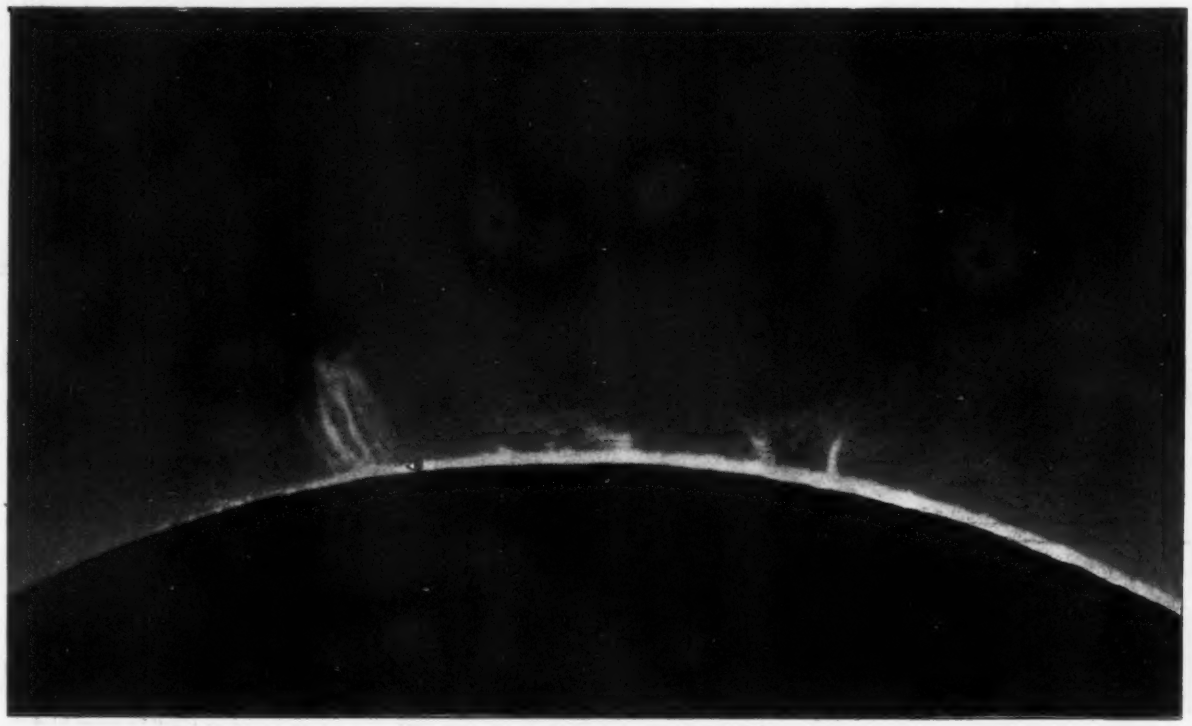


FIG. 1.—PROMINENCES SHOWN BY THE 12-INCH LENS.

Choice of Site.—Three successive years of special observations had enabled the Weather Bureau to determine the relative chances of cloudiness at various points along the eclipse track, and from these results it appeared that the interior of the country was more favorably situated in this respect than those parts of the path lying near the coasts. Certain towns appeared more favorable than others, owing to local conditions, although such special results were less trustworthy than the broad indications already cited. However, as the Eastern stations were to have both a higher solar altitude and a longer duration of totality, and as personal inspection of the ground by me, together with a careful consideration of the Weather Bureau results, seemed to justify the selection, the town of Wadesboro, N. C., was approved by you in preference to stations more remote from Washington. The actual grounds occupied formed a nearly level plat of several acres extent, sheltered from the wind by knolls, buildings, and trees, but being almost the highest land thereabouts, and indeed about 600 feet above sea level. These grounds were freely offered by John Leak, Esq., of Wadesboro. A shed and the necessary piers for instruments were erected in the latter part of April.

Fig. 2 gives a general view of the camp as finally occupied. The equipment of the Smithsonian expedition is shown at the right of the wagon track, while on the left is a portion of that of the Yerkes Observatory. The 135-foot horizontal telescope is under the canvas seen on the right. Its companion tube is hidden by it. On its left extremity is seen, though on a very diminished scale, the cœlostat mirror which "fed" it, and also the box of the 6-inch aperture camera equatorially mounted. Immediately in front of the tube and cutting off a portion of the view are the sheds containing the apparatus for the bolometric study of the corona and that for the large cameras for the 11-foot and other lenses. The great Grubb siderostat and other pieces of apparatus are hidden from view by the sheds. On the right of the sheds and immediately in the foreground is the 5-inch achromatic loaned by the United States Naval Observatory. At the right hand extremity of the long tube is seen the photographic house, which serves equally for the 135-foot lens and for that of the 38-foot focus lens, which latter is in the tube inclined upward.

Nature of the Observations. — The chief aim of the observations was the investigation of the corona, and of this especially the inner portions. This investigation was threefold — photographic, bolometric, and visual. In addition to these main objects there was included the photography of the sky near the sun for the discovery of possible unknown bodies, an attempt to photograph the "flash spectrum" with an automatic camera, and the observation of times of contact both by the ordinary visual methods and by photography.

Pieces of Apparatus Employed.—(a) Apparatus for photographic purposes: For the direct photography of the inner corona the 12-inch lens of 135 feet focus was used as a horizontal telescope in connection with a cœlostat carrying an 18-inch plane mirror. (Fig. 4) Here are shown on a large scale the lenses in question, the extremity of its canvas tube, and the cœlostat and equatorially mounted camera described in the preceding plate. It was also arranged to use with this lens just before second contact an objective prism forming a spectrum upon a plate moved each second by clockwork, and thus suited to catch the "flash spectrum," so called. This necessitated a second tube 135 feet long, inclined at about 8 degrees to that used for the direct photographs of the corona. Both tubes were made of black canton flannel and were 42 inches square with diaphragms of progressively increasing size 10 feet apart. The two tubes were fastened to trestlework and were covered by long canvas A tents. Nearly 1,000 yards of canvas and flannel were thus made up. The

FIG. 2.—THE 5-INCH EQUATORIAL.

* Abstract from Report of S. P. Langley, for the year ending June 30, 1900.

direct tube ended in a small photographic house which had been prepared in sections and was transported from Washington. Plates 30 inches square were here exposed.

The direction of the long tubes was necessarily a matter of care, as they had to be placed beforehand where calculation showed the sun would be, and were incapable of adjustment.

Besides this great horizontal telescope, the 5-inch 38-foot lens was also used for obtaining inner coronal photographs. This lens was mounted upon a pole in such a way as to be in line with the sun from the east window of the photographic house at the moment of totality. A conical tube of white canvas, well blackened within, and 36 inches square at its lower end, ran from the house to the lens, but was not attached to the lens or its mounting. There being thus no provision for following the apparent motion of the sun with the lens, a suitable motion was given to the photographic plates by means of a water clock. With this instrument 11 by 14-inch plates were employed.

Upon the same instrument which carried the 18-inch mirror of the horizontal telescope (shown in Fig. 4) was mounted equatorially a 6-inch photographic lens of 7½ feet focus, provided with a conical tube, so that a considerable field was covered.* A shade glass opaque to violet light was placed over this lens. The purpose of the shade glass was to enable a comparison to be made between the form of the outer corona as photographed with yellow and green light and as photographed with the complete coronal radiations by other lenses shortly to be described.

Within the eastern part of the shed there was mounted upon an improvised polar axis a collection of four cameras, quite ponderous in appearance, but really not very heavy, and well provided as to moving gear by being connected with the very accurate spectrobolometer clock. These cameras were two similar pairs, one with short-focus, the other with long-focus lenses. The former were two landscape lenses of 4½ inches aperture and 40 inches focus, each provided with a 30-inch square plate. In front of one lens was placed a shade glass opaque to violet light. The two long-focus lenses were of 3 inches aperture and 11 feet focus, and were thus like those recommended in the Harvard College Observatory Circular No. 48 as most suitable for a photographic search for a possible intra-Mercurial planet. The axes of these two cameras were inclined so that together they covered a space east and west of the sun about 12 degrees by 28 degrees in extent. Their fields were found to be so nearly flat as to make it undesirable to use a nest of plates arranged upon a curved surface, as recommended in the Harvard circular above alluded to, and each camera had a single plate 24 by 30 inches.

All the photographs with the seven lenses above described were taken upon Cramer double-coated isochromatic plates of great rapidity.

An automatic camera, giving exposures from a break-circuit chronometer beating seconds, was provided for the purpose of securing the times of contacts. This camera had a 22-inch lens with pin-hole aperture, and the exposures were made upon very slow nonhalation celluloid plates 15 inches in diameter, rotated slightly after each exposure by an electrical escapement. One plate was provided for first contact, one for both second and third, and one for fourth contact. As no clockwork was applied to move this camera, the successive exposures made a spiral series of images of the sun, from the appearance of which the gradual encroaching of the moon could be observed.

(b) Apparatus for bolometric purposes: This consisted of a complete bolographic outfit, including not only the great Grubb siderostat with supplementary mirror, but also a double-walled chamber of nearly uniform temperature. Its purpose was to enable the total radiation of the inner corona to be observed, and in addition, if practicable, to determine the distribution of these radiations in the spectrum. The latter observation it was hoped would throw light on the composition of the corona, for it is well known that different substances and different temperatures have each its characteristic energy spectrum. A beam of light from the 17-inch mirror of the great siderostat, reflected due south into the shed, passed through a cat's-eye diaphragm whose aperture was controlled by the observer at the galvanometer, thence to a condensing mirror, which reflected the rays directly back to the focus at 1 meter distance, where was a slit 1 centimeter high and 1 millimeter wide. From the slit the rays were reflected out of the optic axis of the condensing mirror by two parallel plane mirrors, and fell upon a collimating mirror of 75 centimeters focus. Thence they were reflected upon a prism 8 inches in diameter, one of whose surfaces was silvered, so that the prism might be used either to refract or reflect the rays, according as the glass or silvered face was turned toward the collimator. From the prism the rays passed to an image-forming mirror, in the focus of which, at 75 centimeters distance, was the bolometer strip 1 centimeter high and 1 millimeter wide. The bolometer and galvanometer with their accessories were essentially as used for solar spectrum work in Washington, and while the optical train, with its seven reflections and small slit, greatly reduced the radiations, the sensitiveness of the bolometer was yet such that subsequent observations on the full moon gave a deflection of 85 divisions when the aperture of the diaphragm was but 17 centimeters square.

* The focal curve of this lens was determined and it was intended to use a nest of small plates so arranged as to be in focus over a large field. On the night before the eclipse, however, it was so warm that the wax used to fasten the plates softened repeatedly, and after several trials it was found necessary to use a flat plate, on which the focus was good for perhaps 6° from the center.

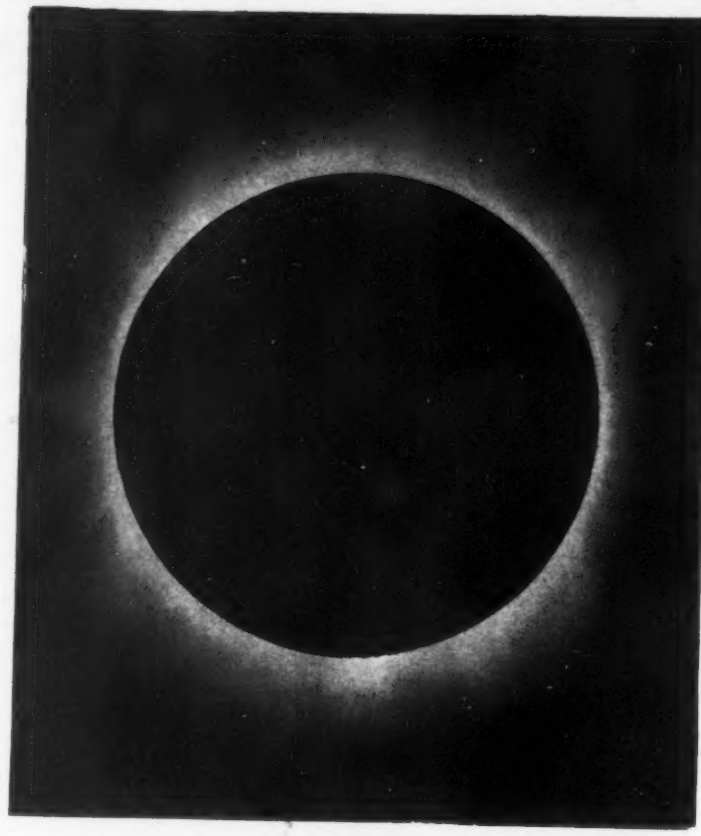


FIG. 3.—CORONA WITH 5-INCH LENS, SIX SECONDS' EXPOSURE.

FIG. 4.—CŒLOSTAT WITH EQUATORIAL CAMERA AND SHOWING THE GREAT LENS AND PRISM.

Nevertheless it was found that no "drift" or "wiggle" was noticed when the glass plate in front of the bolometer case was removed. Accordingly there was no plate in front of the bolometer at the time of the eclipse, and, of course, none was interposed during the observation just recorded.

The expedition was strengthened by the presence of Prof. Hale, of Yerkes Observatory, who used a second beam from the 18-inch cœlostat mirror, also driven by the great siderostat, in connection with bolometric apparatus for the purpose of observing if a difference in radiation could be detected between the coronal rifts and streamers.

(c) Apparatus for visual observations. Four visual telescopes were employed for observing the coronal structure and the times of contact. These were:

A 5-inch of about 6 feet focus, loaned by the United States Naval Observatory, having an equatorial stand and clock.

A 6-inch of 7½ feet focus with equatorial stand, but no clock.

A 3½-inch of 3½ feet focus with rough alt-azimuth stand.

A Coast Survey meridian transit instrument of about 2½ inches aperture and 2½ feet focus used as an alt-azimuth telescope to observe contacts.

THE PERSONNEL OF THE EXPEDITION.

The Director, Mr. S. P. Langley, Secretary of the Smithsonian Institution, observed with the 5-inch equatorial; and the other members of the expedition were assigned as follows:

Mr. C. G. Abbot, aid acting in charge, with Mr. C. E. Mendenhall to the bolometric apparatus.

Mr. T. W. Smillie, photographer of the National Museum (in general charge of photography, including the development of all plates), specially to the direct 135-foot focus camera.

Mr. F. E. Fowle, Jr., junior assistant, to the 38-foot focus camera.

Mr. G. R. Putnam (detailed from the United States Coast and Geodetic Survey) to the determination of latitude and longitude, the observation of times of contact, and the direction of signals.

The Rev. Father Searle, C.S.P., together with Mr. Paul A. Draper and Mr. C. W. B. Smith, to the combination of four wide field cameras.

Mr. De Lancey Gill to the 6-inch photographic telescope and the objective prism.

Mr. R. C. Child to the 6-inch visual telescope, the electrical circuits of the chronograph, the prismatic camera, and the contact camera.

The Rev. Father Woodman, C.S.P., to the 3½-inch telescope.

Mr. A. Kramer, instrument maker, to the movements of the siderostat and 5-inch equatorial.

Besides these there volunteered for the day of the eclipse Mr. Little, of Wadesboro, and Mr. Hoxie, assigned, respectively, to strike signals and to record contacts for Mr. Putnam.

Prof. George E. Hale was connected, as already said, with the Smithsonian party, while at the same time in general charge of the Yerkes Observatory expedition, whose camp adjoined ours.

THE EXPEDITION.

After the preparation of the apparatus and the preliminary rehearsal for the eclipse on the Smithsonian grounds, a freight car was completely filled with the apparatus, and left Washington May 2.

The first four members of the expedition, Messrs. Abbot, Fowle, Kramer, and Smith, left Washington May 3, and were followed in a few days by two more, Messrs. Putnam and Draper, the former of whom, however, returned after determining the latitude and longitude and helping to adjust several polar axes. Messrs.

Smillie, Mendenhall, Child, and Gill reached Wadesboro May 16, and the other members of the party arrived about two days before the time of the eclipse. Pleasant accommodations were found in the town, only about a quarter of a mile from camp, and the greatest courtesy was shown to the eclipse expedition at all times by the townspeople. A pleasant feature was the presence of large parties from Yerkes Observatory, Princeton Observatory, and from the British Astronomical Association. The days and—toward the last—a considerable portion of the nights were busily occupied in adjusting and trying the apparatus. On May 26 and 27 full rehearsals took place in preparation for the final event.

The day of the eclipse was cloudless and clearer than as usual in the Eastern States, though the sky was not exceptionally blue. All the programme was carried out successfully, except only that Prof. Hale's bolometer suffered an accident which prevented him from obtaining bolometric evidence of rifts and streamers, but not from securing other interesting data.

After the eclipse the members of the expedition returned home in nearly the same order as they came, and the last members to leave reached Washington June 1.

THE RESULTS.

1. With the 135-Foot Direct Camera.—Mr. Smillie secured five negatives during the eclipse, all good. Three others which he exposed after totality were of much less value, as was to be expected. The enormous scale of these photographs (the moon's disk measures 15⅝ inches in diameter), together with the excellent detail in the prominences and inner corona, make them most interesting.

Fig. 1 shows a group of prominences on the southwest limb.* As remarked at an earlier page, it has proved impossible to adequately reproduce the delicate detail of the originals. In the two illustrations given the subjects are so marked that a still interesting result is shown even after the loss of the finer structure. But the equatorial coronal streamers, though in the original clearly shown to be finely subdivided, curiously curved and even recurved, interlocked and arched, are so delicate that it was hopeless to attempt their reproduction. Even contact prints fail to show their structure unless made on glass plates, and thus viewed by transmitted light.

Some, but I think not all the prominences, appear to be set each within its little coronal arch, and thus present the so-called "hooded" appearance which was noted in photographs of the Indian eclipse of 1898. I am quite sure, however, that this feature is much less marked than was then the case.

It would hardly seem possible that the directions of the curved equatorial streamers can be assigned to such a simple system of foci as has been sometimes supposed, for their arrangement appears to be complicated to the last degree. Nothing final can yet be said on this point pending a thorough examination, and this it is hoped will yield many interesting results.

2. With the 135-Foot Prismatic Camera.—Nothing of value was secured with this instrument. The plate appears to have been exposed at successive intervals, but was completely fogged over, no spectrum appearing.

3. With the 38-Foot Camera.—Mr. Fowle obtained seven negatives during totality, all good. Others taken after third contact were of little value. What has been said as regards the results with the 135-foot camera applies very well here, except that not quite equal detail was secured, owing to the lesser power of the apparatus. Somewhat greater coronal extension was, however, obtained in the longer exposures, because of the greater focal ratio of the lens, and Fig. 3 is given to illustrate this part of the corona.

4. With the 6-Inch Photographic Telescope.—Mr. Gill obtained an excellent negative of eighty-two seconds' exposure, showing the longest extension of the coronal streams obtained with any of the instruments. It seems probable, however, that a somewhat better result would have been reached with a less exposure or a less aperture. The greatest extension obtained exceeds three diameters from the moon's limb. Here the streamers fade away into the background of sky, as if overpowered by skylight rather than as here ending.

5. The Combination of Four Wide-Field Cameras.—These cameras were all in a measure successful, though not in equal measure, for one of the long-focus and one of the short-focus negatives was better than its mate, the former being on a better plate and in better focus, while the short-focus camera with screen showed unaccountable effects of motion not found in any others.

Comparing the long-focus with the short-focus negatives, the former were far superior both as corona pictures and as showing faint stars. One of the 11-foot focus negatives has probably the best general view of the corona secured by the expedition. (Fig. 5.) On this plate the corona is seen as a whole. It hardly shows the full extent of the corona, which, as seen by the naked eye, extended to nearly three solar diameters, but it exhibits most clearly the curves on either side of the solar streamers, although perhaps not showing quite as great extension as that obtained with the 6-inch photographic telescope.

As regards faint stars and new objects, the better of the two 11-foot focus negatives covering the region west of the sun shows 114 stars, the faintest being of the 8.4 magnitude as given in Argelander's Durchmusterung, a result which, considering the amount of diffused light during the eclipse and the milkiness of the sky, is almost surprising. Six uncharted objects were found upon this plate, which appeared starlike and may conceivably be intra-mercurial planets, though nothing is to be understood as here predicated of them until a later and careful examination of the plates.

This photograph was unsuited for purposes of direct reproduction for the reason that the fainter stars required the best of conditions for seeing even on the original and would inevitably have been lost. It was nevertheless thought interesting to give an accurate map showing all the stars and suspects found. The general reader will perhaps gain a better idea of the value of photography as an aid to investigation when he sees in this map, obtained in eighty-two seconds' exposure, in a brighter than moonlit sky, not only the corona and the planet Mercury just beyond its rays, but more stars near the Pleiades than he can see with the unaided eye in the darkest night. Astronomers are invited to compare this map with the Durchmusterung charts, to see both the strong and the weak points of the plate. It will be recognized that the outer portions of the map show fainter stars than the middle part, and thus it is indicated that advantage in focus would have come if the plate had been slightly concave.

The negative covering the region east of the sun was much less satisfactory, and showed but 13 stars, the faintest being of the 6.3 magnitude. Two uncharted objects were found, but of their starlike character there is less certainty than in the case of four of the six discovered on the western plate.

6. With the Bolometric Apparatus.—The heat of the inner corona was successfully observed, and caused a deflection of 5 divisions as compared with the dark surface of the moon, but its spectrum was too faint to observe with the bolometric apparatus. Both the moon and the corona gave *negative* deflections (18 and 13 divisions respectively) as compared with screens at the temperature of the bolometer, while with only one five-hundredth the aperture the sky where the inner corona was about to appear gave *positive* deflections as compared with the screens, decreasing from 80 to 5 divisions during the five minutes preceding the totality.

These observations indicate not only that the coronal radiation is very slight, but that the *apparent* temperature of the inner corona is below 20 deg. C. For it will be noticed that the bolometer *lost heat by radiation to the corona*, as evidenced by a negative deflection. Hence, when we consider its visual photometric brightness at the point where the bolometric measures were taken, which, judging from the results obtained by several observers during the eclipses of 1870, 1878, and 1898, was at least equal to that of the full moon, it is difficult to understand how the light of the corona can be due largely to reflection of rays from the sun or even to the incandescence of dust particles, for from sources of these kinds, which emit a great preponderance of invisible infra-red rays, the bolometer would have given large positive deflections.

Thus during observations taken two days before the full moon of August, 1900, with apparatus as nearly as possible identical with that used at Wadesboro, but unfortunately with a very hazy and humid and even cloudy atmosphere, *positive* deflections of 55 divisions were obtained from the moon as compared with a screen at the temperature of the bolometer, and 86 divisions as compared with the dark zenith sky.*

Observations on the daylight sky at a distance from the sun also resulted in large positive deflections.

In the case of the moon, as you have shown, about three-fourths of the deflection is due to the radiations of the moon itself, whose surface is slightly warmed by the solar rays, the remaining one-fourth being due to direct reflection of solar rays; but in the case of the daylight sky it was found here that the quality of the radiations was almost the same as that of the rays direct from the sun, so that the heating of the bolometer in this case is almost solely by direct reflection and not from primary radiations due to first warming of dust or other particles in the air.

The important result of a comparison of the radiations of the inner corona, the full moon, and the daylight sky somewhat remote from the sun is that while the three are roughly of equal visual brightness, the corona is effectively a cool and far from intense source, while the moon and the sky are effectively warm and many fold richer in radiation. Hence it would appear plausible to suppose that the corona merely sends out visible rays and that its light is not associated with the great preponderance of long wavelength rays proper to the radiation from bodies at a high temperature. If this be so, the coronal radiation might be compared with that from the positive electrical discharge in vacuum tubes, in which, as researches of K. Angstrom and R. W. Wood have shown, there is neither an infra-red spectrum nor a high temperature. I am not sure whether this analogy can safely be carried further to explain the coronal constitution, but it may be recalled that the earth has in the aurora an electrical phenomenon of this nature; that the coronal streamers appear not unlike an electrical discharge; that the observed polarization of the coronal light is perhaps not necessarily by reflection, for polarization may be otherwise caused, as by the emission or absorption of bodies of peculiar internal structure, or even by magnetic influences, as in the Zeeman effect; that the corona does not seem to grow more red as it recedes from the sun, as we should expect incandescent dust to do, and finally the evidence of coronal spectroscopy seems not inconsistent with the hypothesis of a glow electrical discharge.

7. With Visual Telescopes.—I understand that in your own view, with the 5-inch equatorial, the inner corona appeared to have a much less minutely divided structure than that of 1878, and to be chiefly noticeable in its equatorial as opposed to its polar extensions. Prominences were plainly seen, and especially one large one at the southwest limb.

Mr. Child, with the 6-inch, being the artist of the party, made sketches from which he later prepared in pastel color a representation of the corona and prominences strikingly in accord with the photographs which were subsequently developed.

Rev. Father Woodman, with the 3½-inch, received impressions similar to those of the other visual observers.

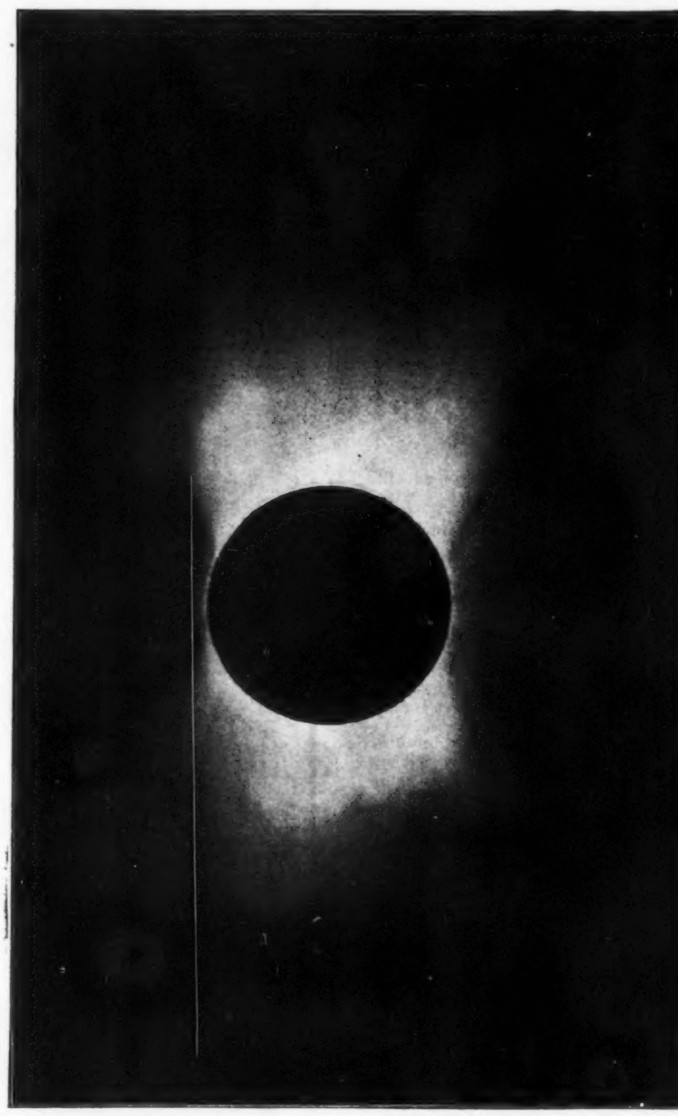


FIG. 5.—GENERAL VIEW OF THE CORONA.

* These are not enlarged, but are portions of the original focal images of over 15 inches diameter already referred to as obtained in the 135-foot focus camera.

* As appears in the Allegheny researches on the temperature of the moon, these deflections would undoubtedly have been considerably increased had they been made in a clear and dry atmosphere at the time of the full moon.

8. Times of Contact.—Mr. Putnam, a part of whose duty it was to direct the giving of signals, observed first, second, and fourth contacts, but missed the third in consequence of being hindered by directing the last signal.

His observations, reduced to seventy-fifth meridian mean time, are as follows:

	H.	M.	S.
First contact	19	36	19.7
Second contact	20	45	15.5
Fourth contact	22	05	37.3

Father Woodman's observations are as follows:

	H.	M.	S.
First contact	19	36	21
Second contact	20	45	16
Third contact	20	46	47
Fourth contact	22	05	26

The photographic contact camera furnished apparently excellent records of first, third, and fourth contacts. These have not been finally reduced, but it is found more difficult to determine the times from them than was expected, and it seems doubtful if this method is desirable to be employed in future.

9. Position of the Camp.—From observations of stars made on five nights, taken in connection with noontime signals transmitted from the United States Naval Observatory, Mr. Putnam determined the latitude and longitude of the camp to be:

Latitude.. 34° 57′ 52″ north.
Longitude. { 80° 04′ 27″ / 5h. 20m. 17.8s. } (west of Greenwich.)

SUMMARY.

The operations of the Astrophysical Observatory during the past year have been distinguished, first, by the publication of the first volume of its Annals, in which the infra-red solar spectrum is the main topic; second, by progress in the preparation of a highly sensitive, steady, and magnetically shielded galvanometer; third, by observations of the total solar eclipse, in which excellent large-scale photographs by the corona were secured, the coronal extensions photographed to upward of three diameters from the moon's limb, the absence of intra-Mercurial planets above the fourth magnitude made nearly certain and the presence of several such between the fifth and seventh magnitude rendered as probable as single photographs can do, and finally, in which the small but measurable intensity of the total radiations and the effectively low temperature of the inner corona were observed by the aid of the bolometer.

C. G. ABBOT,
Aid Acting in Charge Astrophysical Observatory.

THE MINER'S INCH.

A SERIES of 235 observations were recently made in the hydraulic laboratory of McGill University, with a view to a determination of "the miner's inch," and the results of these observations were laid before the Canadian Society of Civil Engineers recently in a paper by Thomas Drummond, B.A.Sc. The records will be very useful in the mining regions of Canada, as furnishing data for delivering water at mines. The "miner's inch" of water, it may be explained, is an arbitrary measure adopted for selling water in mining districts, and is defined as the amount of water discharged by an orifice 1 inch square (or the equivalent fraction of a larger orifice), with a head of from 6 inches to 9 inches. The variation in the head makes the definition rather vague. In British Columbia it is defined as being 1.68 cubic feet of water per minute, or that quantity of water which will pass through an orifice ½ inch wide, 2 inches high, and 2 inches thick, with a constant head of 7 inches above the top of the orifice, and every additional inch shall mean so much as will pass through the said orifice extended horizontally half an inch. Mr. Drummond points out that as a definition this is completely wrong. In the first place, widening the orifice changes the coefficient of discharge, and therefore the discharge itself. In the second place, this orifice actually discharges 2.147 cubic feet of water per minute, instead of 1.68 cubic feet, and this brings out a curious point, that certain shaped orifices with a thickness of 2 inches run full like a short tube, the vein is not contracted, and they actually give a greater discharge than they are supposed to give. The shape of the orifice has a perceptible effect upon the discharge. Circular orifices give the least discharge, rectangular orifices the greatest, and square orifices are intermediate. As the rectangular orifice becomes thinner, the width being the same, it will discharge proportionately more water. A 1 inch by 2 inch orifice, 2 inches thick, is just on the margin between flow with contraction and full bore. If fixed in the vertical position, with longest diameter vertical, the vein contracts. If fixed in the horizontal position, with the longest diameter horizontal, it will also contract, but if rubbed with the fingers on the edge, it will run full for a time, and then contract again. If kept running full in this way, it will discharge about 1 cubic foot of water per minute more than when full contraction takes place.

Mr. Drummond's measurements lead him to the following conclusions: There are difficulties in the way of delivering absolutely exact quantities of water, and these quantities cannot be measured out as a pound of tea is weighed over the counter. The definition of the module or unit, however, should be correct within a reasonable limit of error. If it is a definition of a single miner's inch from an orifice of one square inch, it should go no further. If the inch is defined as being some practical part of the discharge from a larger orifice, it should go no farther than the capacity of that orifice, and as it is an unknown quantity to the outside world, the discharge should be given in cubic feet per minute. Convenient discharges are 1½ and 2 cubic feet. The flow under low heads is irregular. Heads of 1 foot or more are not convenient, because the water is delivered from ditches or flumes where the depth of water is never great. The question thus resolves itself into a choice of a standard module or unit from a flow under two conditions: (1) With a low head of 6¼ inches above the center of the orifice, giving a discharge of 1½ cubic feet per minute, with the advantage that it is already partially recognized as the miner's inch, and with the disadvantage that the flow is irregular. (2) With a head of 11½ inches above the center of the orifice, and a discharge of 2 cubic feet per minute, the flow being much more regular, but the quantity discharged new to the people. Definitions of both inches are given, but the author favors the last.

Definition No. 1 of Miner's Inch.—The water taken into a ditch or sluice shall be measured at the ditch or sluice-head. It shall be taken from the main ditch, flume, or canal, through a box or reservoir arranged at the side. The orifice shall be fixed vertically at right angles to the delivering water way, and the edges and corners shall be sharp. The vein shall be fully contracted. The distance between the sides and bottom of the orifice and the sides and bottom of the water-way shall be at least three times the least dimension of the orifice. The orifice shall discharge freely into air.

One miner's inch of water shall mean one-quarter of the quantity which will discharge through an orifice 2 inches wide and 2 inches thick, made in a 2-inch plank, planed and made smooth. The water shall have a constant head of 7¼ inches above the center of the orifice. It shall mean a discharge of 1½ cubic feet per minute.

In definition No. 2 the first part is precisely the same, the latter part is changed as follows:

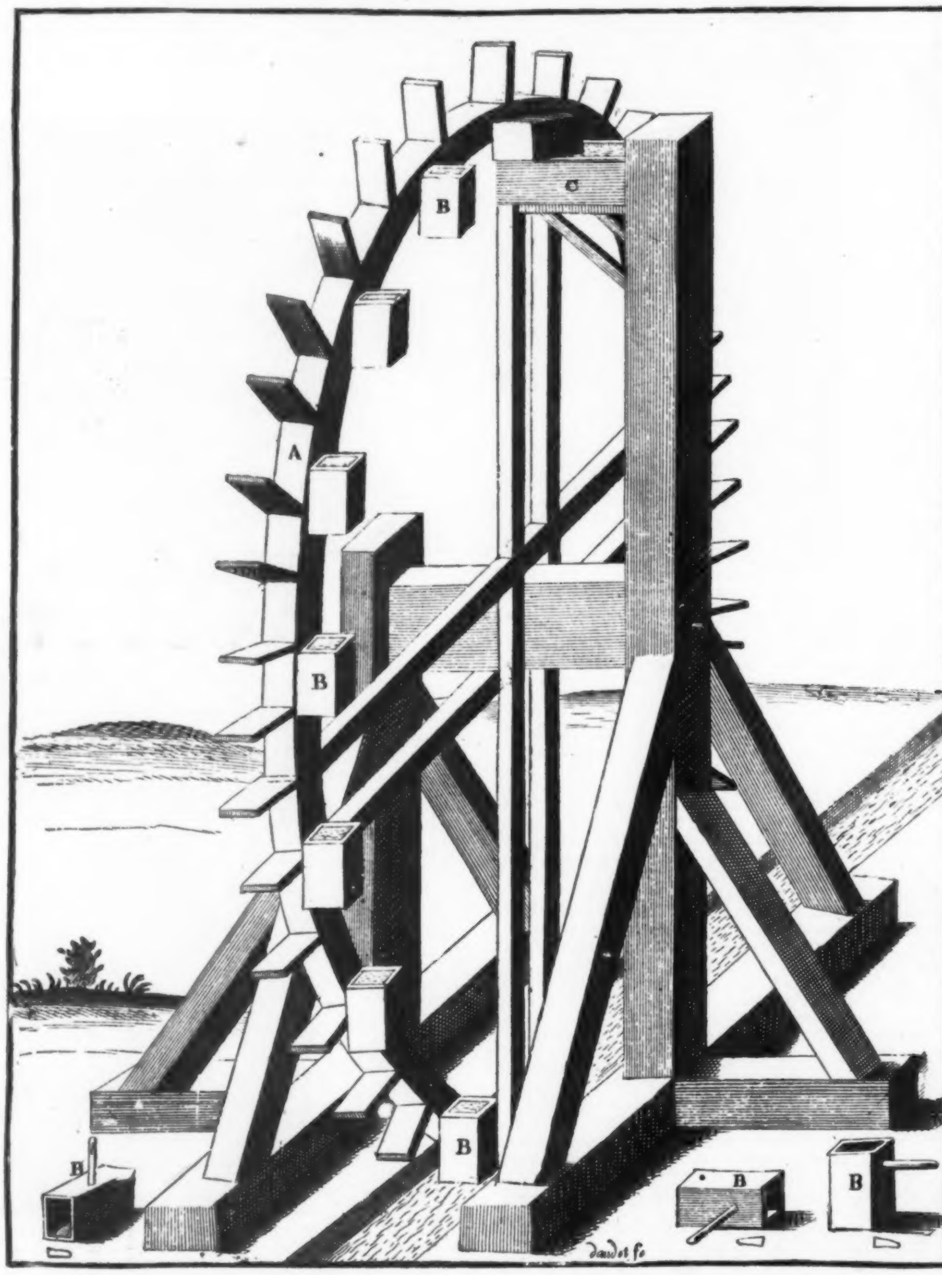
One miner's inch of water shall mean one-quarter of the quantity which will discharge through an orifice 2 inches wide and 2 inches thick, made in a 2-inch plank, planed and made smooth. The water shall have a constant head of 11½ inches above the center of the orifice. It shall mean a discharge of 2 cubic feet per minute. A 1-inch orifice may run full, but no experiments were made on this point. These discharges are from a standard brass orifice, and are actually 0.478 and 1.997 cubic feet per minute. The discharge through a wooden orifice 2 inches thick is slightly greater than for a standard orifice, so that these discharges should be almost exactly 1½ and 2 cubic feet per minute. No attempt was made to reduce the observations to a common temperature. The temperatures for the brass orifice varied between 31.7 deg. and 46.5 deg. F., a range of 9.5 deg. F., with an average temperature of 48 deg. F. The temperature for the wooden orifices varied between 45 deg. and 50 deg. F., with an average of 48 deg. F. The mean temperature for the whole was 45 deg. F.—Canadian Engineer.

MACHINE FOR RAISING WATER FROM A RIVER TO THE HEIGHT OF THE DIAMETER OF A LARGE WHEEL.

THE buckets, *B*, are attached to the rim of a large wheel, *A*, by iron pins that are movable and that suspend them by the part nearest their mouth, so that, although the wheel, *A*, revolves, these buckets are, through their own gravity, always in equilibrium, and empty the water that they have scooped up, in passing into the river, only into the reservoir, *C*.

Upon examining the figure it will be easily understood that the large wheel, *A*, is made to revolve by means of the paddles on its circumference and of the current of the river, and that the edges of the reservoir, *C*, cause the buckets, *B*, to tilt so as to empty the water with which they are filled when they reach the top of the machine.

Accompanying the figure there are sketches of the buckets, *B*, detached from the wheel and placed in different positions in order to show the manner in which are placed the iron pins that traverse the fellies of the wheel and are held by keys.—From Recueil d'Ouvrages Curieux de Mecanique et de Mathématique.



MACHINE FOR RAISING WATER FROM A RIVER TO THE HEIGHT OF THE DIAMETER OF A LARGE WHEEL.

MACHINERY AND THE MAN.*

By ALEXANDER E. OUTERBRIDGE, JR.

THE substitution of automatic or semi-automatic machinery for hand labor in industrial establishments has progressed so rapidly and has attained such large proportions, more especially in this country, during the past few years, that the subject is attracting much attention, and a wide diversity of opinion is expressed by students of industrial economics, employers and others, as to the probable influence of this far-reaching evolution upon the future intellectual development and material welfare of the wage-earner.

An address was recently given by a well-known teacher of economics upon the present aspect of labor in this country, and it was an able exposition of the views of one who has apparently studied the subject

* An address to graduating students of the Schools of Drawing, Machine Design, and Naval Architecture, of the Franklin Institute, April 26, 1901. From the Journal of the Franklin Institute.

mainly from a theoretical and scholastic point of view. According to this authority the extensive substitution of automatic machinery for hand labor, now evident in all trades, is, of necessity, more or less detrimental to the intellectual development of the wage-earner, since the work which he is called upon to perform is reduced to the simplest routine operations involved in feeding a machine with raw material; that the monotony of his task is very depressing, and that the modern system of minute subdivision of labor develops a hopeless feeling in the mind of the operative, because he knows that there is little or no opportunity for him to become a skilled master of any trade through his daily work; that in the old days of the "apprenticeship system," when boys were indentured to masters and taught the principles and practice of a trade, there was more incentive to ambition, and, consequently, a quicker intellectual growth of the young mind, and a keener desire on the part of the youth to become a thorough workman. In a word, we were told that the modern system is injurious to the progress of the wage-earner. This is, perhaps, a natural view for one to take who looks at the subject from a theoretical standpoint only, but daily observation in large industrial works, covering a period of years during which a revolution has occurred in methods of conducting manufacturing industries, has given me a different opinion, based upon a different point of view; moreover, long before the invention of modern automatic machinery, and even before the birth of the factory system, similar views to those which have been given were expressed by the best-known writers on economics. In 1776 Adam Smith, in his great work, "The Wealth of Nations," said:

"They [the working people] have little time to spare for education. . . . As soon as they are able to work they must apply to some trade by which they can earn their subsistence. That trade, too, is generally so simple and uniform as to give little exercise to the understanding, while, at the same time, their labor is both so constant and so severe that it leaves them little leisure and less inclination to apply to or even to think of anything else."

The elimination of exhausting manual labor by the substitution of powerful machinery for puny arms has emancipated labor in our day from its hardest tasks, and has given to the worker both inclination and leisure for the development of his intellect in various ways that were impossible under former conditions.

It is not true in point of fact that the operator of a modern labor-saving machine is restricted to the mere feeding of the machine with raw material; he is encouraged and expected to do very much more than this in order to obtain the best results. As an illustration, I may mention a case in point where two men work side by side, tending duplicate machines. One man earns nearly twice the wages of the other, for the simple reason that he can produce in ten hours nearly twice the quantity of finished material, made to standard measurements, the permissible limits of variation being probably but a few thousandths of an inch. The difference in efficiency is in the men, not in the machines.

It is not merely the ability to turn out a maximum amount of work from a modern machine that constitutes a skilled operative. No matter how nearly automatic the machine may be, it is still subject to human guidance, and no matter how nearly perfect its construction, its work is still subject to final correction and control by the hand of the operator. I am satisfied that in all trades where automatic machinery has been extensively introduced for the purpose, it may be, of supplanting hand labor, the ultimate result has proved beneficial to the workers in raising the general average of intelligence, and, furthermore, that it has largely increased the opportunities for labor.

This statement may appear at first sight somewhat paradoxical, but a little examination will, I think, convince you that it follows as a logical sequence. The cheapening of manufactured articles through the aid of machinery enlarges the demand and increases the production to such an extent that those things which were heretofore regarded as luxuries of the rich, soon become ordinary conveniences in the economies of life. This increased production necessitates the employment of a larger number of operatives than were formerly required to make the same articles by hand.

Several years ago a labor-saving machine (an electric traveling crane) was introduced into a certain department of a large manufacturing establishment, and immediately displaced no less than sixty helpers. Since then many other machines of like character have been installed, yet the number of workers in this establishment is more than fifty per cent greater today than before, the total number of wage-earners in these works having risen from a little under 5,000 at the time alluded to, to over 8,000 men at the present time, and the works have grown to be the largest of their kind in the world.

The introduction of labor-saving machinery has proved beneficial to the workers in many other directions. It has shortened the hours of labor; it has improved the sanitary conditions in workshops; it has increased wages; it has increased the purchasing value of wages, and has elevated the social plane of the worker of the present day above that of his predecessors.

Finally, I may say that I believe the opportunities for advancement of the wage-earner in this country are to-day far greater than at any previous time, and that this fortunate condition of affairs is due largely to the educational influence of machinery upon the wage earner, and to his emancipation from grinding toil by the aid of modern labor-saving machines.

The majority of men holding responsible positions in large industrial establishments to-day have risen from the ranks of operatives. As a striking illustration I may allude to a remarkable instance, that of a comparatively young man who now stands at the head of the most stupendous industrial corporation the world has ever known, who, twenty years ago, began his work at the bottom of the ladder, and has risen to a position which is entirely unique, being now the central figure in the iron and steel industry of the country, and the president of a corporation with a capital exceeding $1,000,000,000! This is, of course, an extraordinary instance, and is not to be taken as representing an average case, but other illustrations might be given, all tending to show that the substitution of modern labor-saving machinery for hand labor has proved to be one of the greatest of all benefits to the wage-earner. The opportunities for lucrative employment and rapid advancement to young men properly equipped, entering the industrial establishments today are greater than at any previous time within my recollection.

A NOVEL FIRE ESCAPE.

WE illustrate herewith a novel fire escape invented by a Herr Scherrer and exhibited at the Vincennes Annex of the Paris Exposition, where it is applied to an elegant six-story tower situated upon the bank of Lake Daumesnil.

The window shutters of the different stories are fixed to a vertical shaft that extends from the top to the bottom of the structure, where it rests upon a bed of balls and is capable of taking on a rotary motion around a vertical axis. Each of these shutters carries in the interior a double metallic ladder, one part of which is capable of sliding on the other, but in an inoperative position is held by a bolt arranged at the upper part of the shutter. When the shutters are closed their external aspect offers nothing peculiar, and, consequently, the harmony of the structure is in nowise interfered with. If a fire breaks out on any story whatever, it suffices to maneuver a winch, which, acting through a rack upon the vertical shaft, causes the rotation of the latter, and, consequently, the simultaneous opening of all the shutters. After the latter have described a circle of ninety degrees, all the upper bolts abut against the masonry, open spontaneously and permit of the fall of the interior ladders, each of which fixes itself to the upper part of the one secured to the shutter of the story beneath.

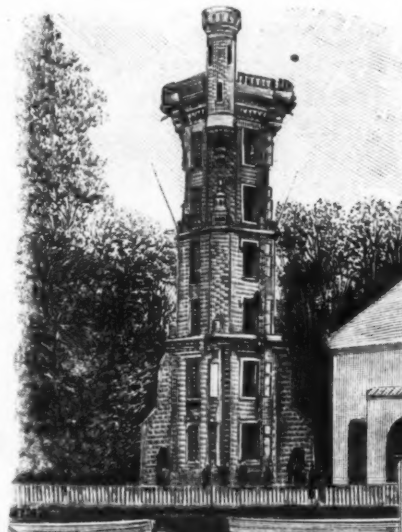


FIG. 1.—TOWER PROVIDED WITH THE SCHERRER FIRE ESCAPE AT VINCENNES.

FIG. 2.—THE SCHERRER FIRE ESCAPE INSTALLED AT THE BARRACKS OF THE ELEVENTH REGIMENT OF FOOT-GUARDS AT BERLIN.

In this way it is possible, in less than three seconds, to have a ladder extending from the top to the bottom of the building. The apparatus can be set in motion from any story and the shutters be opened instantaneously. Moreover, the winch by means of which is actuated the shaft that supports the shutters is ordinarily mounted in such a way as to press against a small commutator and break the electric current in a circuit connecting the different stories with each other. When the winch is grasped in order to maneuver the apparatus the current is immediately established, and on each story actuates electric gongs and indexes that show on what story the fire has broken out. Fig. 2 represents an interesting experiment that was tried with the apparatus at the barracks of the Eleventh Regiment of foot-guards at Berlin. The number of men that it is seen supporting will give an idea of the strength of the ladder. In the experiment under consideration the descent was made very easily, and 16 persons found it possible to escape from the four stories of the barracks in 72 seconds. Other experiments made in schools and workshops have shown that women and children can utilize this apparatus without any danger.—For the illustrations and the above particulars we are indebted to La Nature.

GASOLINE ENGINES FOR SAILING VESSELS.

THE use of American-made gas and gasoline engines as auxiliaries in sailing vessels has passed the experimental stage, and a San Francisco firm now has the honor of having equipped an entire fleet of foreign-owned vessels engaged in the South Sea Island trade. Among the more important of the advantages urged for the employment of such engines for auxiliary power are the following: First, economy of maintenance. If the loss of coal in a steam plant is considered, for the time required to generate a head of steam, and also for the time the vessel is not actually under way, during which steam is kept up, the gasoline engine power being equal, will be found more economical than steam. There is no waste of fuel. When it is necessary to have power, a turn of a valve, a spark, and the engine is in full operation. When power is no longer desired, the mere closing of the valve and the turning of the switch stops it, and all use of fuel ceases.

A second factor which is largely considered in this connection is the fact that with steam as auxiliary power an engineer and firemen are required. With the gasoline engine no addition to the ordinary crew of a sailing vessel is needed, for one man, properly instructed in the starting of the engine, is all that is needed, and he can attend to the whole thing.

In the matter of room, the gas engine has a great advantage over steam. In many ships the engine-room space over all is about 10 by 12 feet. The storage tanks for gasoline or distillate are not nearly so bulky as boilers, and a vessel equipped with gas power has made the run to Honolulu, 2,000 miles, very comfortably by carrying a reasonable reserve supply of fuel in drums on deck.

Another great expense to which sailing vessels are continually put is towage. When a vessel of this class seeks to enter a harbor, a tug is necessary, particularly on this coast, but with auxiliary power she can furl her sails, take on her pilot and go in under her own power even more advantageously than the tug could take her.

The saving in this item alone in a few years will offset the cost of an auxiliary plant.—From The American Exporter.

EXPOSITION OF AUTOMOBILES AT BRUSSELS.

THERE has been held at Brussels annually since 1893 an exhibition of means of locomotion, which during the first few years was devoted to cycles, but this year was announced as an "exposition of new locomotion." It opened March 17 and closed March 24. In view of the increasing use of automobiles, I believe it will interest our manufacturers to know something of the machines used here, and I note a few of those exhibited.

The Pieper manufactory, of Liege, displayed, among other apparatus, an attractive vehicle of medium size, of normal speed and of advantageous price; also an automobile boat which is expected to become very popular in this country.

The exhibit of W. Dierman & Co., of Herstal, Belgium, embraced the electromobile, Krieger system, as well as five automobiles remarkable for their speed and comfort, run by electric motors easily recharged by means of transportable accumulators.

An elaborate exhibit by the Germain Association included: A voiturette, 6 horse power (easily increased to 7½ horse power), four back-speed treadles, three pneumatic brakes, 90 millimeters, to accelerate or reduce speed—price, 8,000 francs, or $1,544 (this model has largely contributed toward establishing the reputation of the Daimler-Phenix motor, and more than two hundred of this make are in use in Belgium); a Duke, 6 horse power, with pivotal back seat —price, 8,600 francs ($1,659.80); a six seat closed omnibus, reposing upon an extended frame, the upper part adjustable, capable of being replaced by seats, thus transforming the vehicle into an open brake—price, 9,450 francs ($1,823.85); a second omnibus similar to the preceding, of 12 horse power, especially designed for chateau service—price, 16,550 francs

($3,194.15); a light automobile of 12 horse power, two places, with four equal-sized wheels, the heliocoidal blades in aluminium, frame in wood, fortified by iron bands, etc., reversible, four speeds, double lighting, and triple-degree radiator front—price, 15,600 francs ($3,010.80).

The Germain Association also exhibited a complete series of stationary motors, ranging from 3, 4, 6, 8, 12, 16 to 18 horse power. These are easily transported and are much sought for illuminating and agricultural purposes in country districts. There was also a motor with revolving treadle, mounted on a light body, especially designed to operate the rudder of a boat.

The "Compagnie Générale d'Automobiles," rue de Brabant, Brussels, exhibited its latest construction—a light carriage, running on four equal-sized wheels. The 5 horse power motor is a Dion-Bouton, transmission by shaft and joints, triple speed, and double band brake—price, 4,800 francs ($926.40).

Guillon & Co., rue Pletinckx, Brussels, made an exhibit of useful novelties, among which I may mention a bicycle and a tricycle run by petroleum; a small trolley carriage, easily adjusted to any bicycle, and used for delivery purposes—price, 175 francs ($33.77), and carrying capacity, 100 kilogrammes (220 pounds). A motor of 1½ horse power also attracted considerable interest, inasmuch as it can be adapted to any bicycle of good make. It weighs 12 kilogrammes (26.4 pounds) and costs 450 francs ($86.85). It was one of the most attractive novelties exhibited.—George W. Roosevelt, Consul at Brussels.

MECHANICAL TRACTION IN PARIS.—II.

THE tramway system in Paris and the suburbs is being exploited by five companies, apart from the Compagnie Générale des Omnibus, possessing a total length of 321 miles of line. The concession for the first mechanical tramway authorized in the department of the Seine was granted in 1872, with the stipulation that the line inside the city should only be conceded until 1910, so as to respect the monopoly of the Compagnie Générale des Omnibus. In the following year the tramway company entered into an arrangement with the Compagnie Générale des Omnibus, whereby it consented to pay a royalty for the urban line. The line was not completed until 1877, and it proved such a failure that in 1882 the company went into liquidation. Five years later the existing company was formed under the title of the Compagnie des Tramways de Paris et du Departement de la Seine. It purchased the whole of the lines and rolling stock from the liquidator for 5,600,000 francs, and started to work the line, despite the opposition of the Compagnie Générale des Omnibus, which would not recognize the new concern, and it was only in 1898 that the Compagnie des Tramways de Paris et du Departement de la Seine was officially authorized to exploit its system, though it had actually been doing so with fair success for seven years previously. The company serves a very wide area to the north and west of Paris, and the length of its system is 78 miles, which is being increased by several new concessions. The whole of the system is worked electrically. The Compagnie Générale Parisienne Tramways Sud was formed in 1880, and started to replace animal by electrical power on its lines in 1898. It takes in the south part of the city from the Arc de Triomphe to Montparnasse and the Bastille, and possesses a large number of suburban lines, connecting Charenton with the Bastille, Ivry, Choisy-le-Roi, and Villejuif with the Chatelet, and Malakoff with the central markets. The Compagnie des Tramways de l'Ouest Parisien was constituted in 1899, to put the Champ de Mars and Auteuil into communication with Chatenay, Billancourt and Boulogne. The lines are worked electrically by overhead contact outside the city, and by the Diatto system of surface contact inside. The energy is supplied from a power station recently erected at Molineaux. The Compagnie des Tramways Mecaniques des Environs de Paris utilizes the urban lines of the Tramways de Paris et du Departement de la Seine for reaching the Opera and the Madeleine, and its system covers a considerable area as far as St. Germain and Poissy, and by acquiring most of the stock in the Compagnie de Paris et St. Germain, and the Compagnie d'Enghein à Montmorency et à St. Gathien, it has secured control over these lines. It has been employing steam cars on its old lines, but the new ones are to be worked with electrical traction, for which a power station has been constructed at Bezons. The company has recently obtained concessions for five new lines opening up Le Pecq, Courbevoie, Reuil, Chatou and Houilles. The Tramways de l'Est Parisien was formed in 1899 to amalgamate three old companies, and is laying down several new lines to connect up the various suburban towns to the east of Paris, with penetration to the Place de la Concorde, the Opera, and the Place de la République.

It may be said in passing that this remarkable development of mechanical tramways is not confined to Paris, but is pretty general throughout the country, and is due to the creation of eight powerful "trusts," possessing an aggregate capital of 131,500,000 francs. So far as Paris is concerned, the tramways are under the control of the Société Française Thomson-Houston and the Compagnie Générale de Traction. During the past four years there has been a very keen rivalry between these two bodies, and each has been trying to secure control over the different tramway companies by purchasing the bulk of the stock and obtaining concessions for new lines. The result of this competition is that the Compagnie Thomson-Houston is equipping the southern lines, while the Compagnie de Traction, which exploits the Diatto patents, is introducing this system on the lines in the east of Paris. As soon as the powerful syndicates began to interest the public in the financial side of tramway undertakings, speculation became rife in these stocks, and for a long time traction securities boomed more than any other class of stock in Paris. This may not have been good for the investing public; but it seemed for the time being to be doing a great deal of good in stimulating tramway enterprise. Plenty of money was forthcoming for the construction of tramways; the different syndicates struggled fiercely for concessions, and any sort of concess'on was eagerly snapped up. With electrical traction it was supposed that the working cost could be reduced to such a figure that if a line did not bring in a profit it would, at any rate, not result in an actual loss, and lists of new concessions always looked well in the annual reports of directors. The competition did something else; it entirely modified the conditions under which concessions were granted. Tramway, like railway, concessions, are always given by the State, and it has been the custom for the State and the local authorities to allow subsidies under conditions where the company is not sure of being able to make the venture pay; but when a number of powerful syndicates is competing for concessions there is no question of subsidies, and they are, in fact, ready to submit to all sorts of onerous restrictions. The concessions are usually granted for a period of thirty years, at the end of which time the State or the municipal authorities have the option to buy up the installation at half the nominal value. In their feverish struggle for concessions the syndicates did not always pay sufficient attention to the commercial possibilities of the lines. Some of them swallowed up enormous sums of money, and a great deal of capital was lost in pure speculation. The boom in tramway stocks suddenly fizzled out when it was found that the Compagnie de Traction was in difficulties, and was no longer able to hold its own against the Thomson-Houston and other powerful financial houses who were interesting themselves in tramway enterprise. The Traction was only saved from liquidation by the assistance of London and Paris financiers, who came to its aid and enabled it to drop the unprofitable concessions and start upon a new programme. The experience has not been lost, for it has shown the folly of creating a speculative bubble in tramway stocks, and there is some talk of the Traction and the Thomson-Houston joining forces, so as to resist the other groups of financiers who have entered the field. It may be questioned, however, whether such a fusion is possible in view of the fact that both companies are exploiting entirely different systems; but if they bury the hatchet and devote their energies to the carrying out of enterprises already in hand, the development of the tramway system will make steadier and more satisfactory progress.

Another thing that helped to bring about a slump in tramway securities was the unsatisfactory nature of returns for the whole of the tramway system actually completed in France during the first three months of 1900. The total length of the system in France was 2,345 miles, or 2,492 miles including sections over which more than one company bad running powers. The total cost of establishing this system was 455,097,103 francs, and the excess of receipts over expenditures per kilometer was only 453 francs, as compared with 929 francs in the first quarter of 1899. This does not look very encouraging, but it may be partly explained by the fact that a large proportion of the lines had only recently been equipped with mechanical traction, and some allowance must be made for the troubles that are usually met with in enterprises of this kind. It frequently happens that mechanical lines start unfavorably through the reluctance of the public to take full advantage of fresh facilities, and the difficulties of the company getting their lines in thorough working order; but once the advantages of the tramways are appreciated and a regular service is assured, the receipts and profits go on increasing rapidly every year. So far as the Paris tramways are concerned, it should be remarked that the returns apply to the period immediately preceding the Exhibition, when the traffic was of a normal character. The compressed air cars of the C. G. O. on the Louvre-St. Cloud and the Louvre-Vincennes lines resulted in a loss of 6,230 francs per kilometer, and on the lines served by horses there was a gain of 2,455 francs. But this latter figure is very misleading, because the statistics do not take into account the compressed air and steam cars running on the "horse" lines; and it should further be pointed out that horse-drawn cars serve thickly populated districts, while the mechanical cars between the Louvre and St. Cloud are employed because animal traction was an absolute failure. The Compagnie des Tramways de Paris et du Departement de la Seine made a profit on its electrical lines of 2,467 francs per kilometer, and the receipts of the Compagnie Générale Parisienne des Tramways were 1,851 francs in excess of the expenses per kilometer. The profit secured by the Compagnie des Tramways de l'Est Parisien on the electrical line from the Place de la République to Romainville was 5,248 francs a kilometer, and the cable tramway from the Place de la République to Belleville made a profit of 11,352 francs a kilometer. These returns show that while mechanical traction, by insuring a more active service, enormously increases the profits where the traffic is heavy, it is hopeless to expect to make tramways pay in thinly populated districts where the traffic is small and irregular, and the vehicles for the most part are run without load. The experience of the past few months seems to have brought this fact home to the companies, who are disposed to be more careful in their calculations as to the possibilities of new districts affording enough traffic to warrant them in laying down tramways.

We give this summary of the latest official returns because they undoubtedly helped to precipitate the crisis which recently came over tramway securities, but the reports of the Paris companies for 1900 show that the results were much more satisfactory. The Compagnie Générale Parisienne des Tramways, which has obtained a prolongation of its old concessions up to 1930, so that the whole of them will expire at the same time, has reduced its fares to ten and fifteen centimes, and wages have been augmented 30 per cent. Notwithstanding this, and perhaps because of the low fares, the profits have been increasing in a very encouraging manner. On the Bastille-Charenton line, which is worked by overhead contact, the receipts in 1900 amounted to 1,100,955 francs, whereas in 1897, when animal traction was employed, the receipts only totaled 304,608 francs. On the Etoile and Montparnasse and Montparnasse-Bastille lines the receipts in January were 38 per cent more than those for the first month of 1900. The conduit system employed on these lines has proved very satisfactory. The Tramways Nord were unable to make any profit so long as they used animal traction between St. Denis and the Opera, but since they employed accumulator cars, which are notoriously more expensive than other systems of mechanical traction, they began to get good profits, but it should be remarked that the big gradients on this line rendered successful exploitation with horses practically impossible.

The creation of this vast system of tramways has, as might have been expected, presented no little difficulty, and the public who have been watching the development of mechanical traction with a great deal of interest, began to lose some of the confidence in the safety of vehicles propelled by motive power when an extraordinary and inexplicable series of accidents took place that threatened at one time to throw discredit over the whole system. One of the claims for the mechanical tramcar is that, being extremely flexible, the speed can be easily graduated to suit the varying traffic, but it was this flexibility that was partly responsible for the long series of tramway accidents that took place during the greater part of last year. The number of tramcars in circulation had been increasing at a much more rapid rate than the supply of competent drivers, and as these were usually omnibus and cab drivers who were transformed into "mechanicians," their education was not always complete when they took charge of tramcars, and their confidence in the vehicles led them to indulge in a good deal of recklessness. The maximum speed at which tramcars are supposed to travel is 12½ miles an hour, but as drivers have to run to time, and incur fines if they are late, they are disposed to far exceed the legal limit when time has been lost at the stations. The result was that cars were run at highly dangerous speeds, and when an accident was imminent the inexperienced driver lost his head, or else did not take into account the slipping of the blocked wheels on the greasy rails. By far the majority of the accidents arose from this cause, but there are others which still remain unexplained. A compressed air car, for instance, was standing near the Trocadero at the top of a long gradient. The driver got down to give assistance to another car which could not start on the up grade, and before he could return to his own vehicle it began moving, and, increasing in momentum down the Avenue du Trocadero, left the rails and dashed into a tree. Had it not been for this obstacle the accident would have become a serious catastrophe. One of the passengers was killed and several others severely injured. The driver alleges that before getting down from his car he applied the two sets of brakes, and, in fact, this seems extremely probable, since he had stopped his vehicle on the down grade. The only explanation he could give was that the passengers in getting in and out of the car had given a swaying movement to the vehicle which, in some way or another, released the brake mechanism. However this may be, when the wrecked vehicle was placed on the rails again the brakes were found to act perfectly, and the vehicle was driven to the depot by its own power. Such accidents as these, however, are extremely rare, and in the great majority of cases they are due simply to excessive speeds, and could be easily avoided by insisting upon a more rigid observance of the regulations. The Prefect of Police had been giving attention to this matter, and recently had an interview with M. Moreau, the representative of the employes of the Compagnie Générale des Omnibus, with a view to deciding what measures should be taken to prevent accidents. M. Moreau suggested that the time-tables be modified and the stoppages at the stations limited, so that there would be no excuse for the cars exceeding the normal speed over the route. He pointed out that one cause of excessive speeds was the liability of the driver to be fined if he should be late at the stations, and if the driver were not threatened with punishment for failing to keep time, one of the most prolific sources of accidents would be removed. He also urged the necessity of placing signals at crossings where the traffic was heavy, so that cars would only be able to pass when the lines were clear. All these suggestions have been approved of by the Prefect of Police, who has invited the companies to send in reports indicating where the signals should be put, and the cost of them is to be defrayed by the companies in proportion to the number of vehicles passing over the points. M. Moreau also objected to the running of trains of cars such as those working the line between the Louvre and the Point du Jour, where as many as half a dozen cars are sometimes drawn by one motor vehicle. He said that the danger of these heavy trains was that they could not be promptly stopped by the brakes, but the Prefect remarked that they only ran at very long intervals, and that as the route along the right bank of the Seine is not a particularly busy one there does not seem to be any danger if the cars are driven at a normal speed. Moreover, if the police regulations are strictly observed, it is not easy to see how an accident can possibly take place at the crossings. These regulations insist that a mechanical car must stop on reaching a crossing, and must not proceed until the driver has assured himself that there is no danger of collision with the vehicles crossing his path. The mechanical car has always a precedent over the horse-drawn car. The driver is required to reduce his speed whenever necessary, when he must take into account the state of the rail, that is to say, whther he can stop instantaneously, or whether the vehicle is liable to slide after the brakes are applied. Seeing the weight of some of the tramcars, this restriction is a very important one, because, however slowly the car may be proceeding, the dynamic force exerted by the vehicle when slipping after an application of the brakes would prove disastrous for any vehicle it ran into. The efficiency of these regulations is proved by the fact that since the companies have been obliged to observe them there have been extremely few accidents of any kind, and the only one that has had to be recorded recently was a collision between two Diatto cars in the Avenue Gambetta. One of the cars was crossing the avenue when another came down upon it at a terrific speed, smashing the vehicle and injuring eight passengers. The cause of this accident appears to have been the bursting of the pipe of the compressed air brake, and the hand brake was not sufficient to hold the car in on the slippery rails, the more so as the vehicle must certainly have been going at an excessive speed.

A source of trouble which is happily very rare, and

will, to a certain extent, be obviated in the future, is the stranding of cars in winter when the roads are covered with snow, or when ice on the rails creates such a resistance that the vehicles are unable to proceed until an army of men have been engaged to clear the way. Only once has such a state of things happened in Paris. During January last there was a fall of snow in the afternoon which melted as soon as it touched the ground, and in the evening there was a sharp frost which covered the roads and rails with a layer of ice that entirely stopped all vehicular traffic, and for some hours there was the unusual sight of long lines of tramcars being unable to proceed. A still more serious matter was the dislocation of the electrical system whenever there was a fall of snow. This would never have happened if the tramway companies had been allowed to clear the track themselves, but as soon as the snow put in an appearance the municipal authorities distributed salt all over the principal thoroughfares, which melted the snow and produced a strong solution of saline mud. This mud, by filtering in around the surface contact plates, created short circuits, while in the slot system it filled up the conduits, and forming a conductor for the electricity, prevented the lines from working. On the companies making strong representations to the authorities they were given a certain time to clear the tracks before salt was put down on the roads, and the Thomson-Houston Company employed an electric brush similar to that used in the United States. This experiment proved successful, and it is probable that these precautions will prevent any further suspension of the electrical tramway service in winter.—The Engineer.

A HISTORICAL SKETCH OF SLAG CEMENT.*

By Prof. WILLIAM KENDRICK HATT, Purdue University, Lafayette, Ind.

THE following paper gives an elementary statement of the nature and properties of slag cements.

A statement in general of the processes involved in the manufacture of cement from slag material or from limestone and clay material, will make clear the discussion which follows.

A Portland cement, commonly so called, is made from either pair of the following raw materials artificially mixed together in a finely divided form:

Compact limestone with from 18 to 20 per cent of clay.

Chalk and clay.

Marl and clay.

Clay-bearing limestone properly dosed with clay or shale, or limestone. This mixture is calcined at a high temperature to nearly the point of fusion. The resultant clinker is ground to a fine powder, and in this condition called Portland cement.

A "slag cement," commonly so called, is made from the cinder or slag which results when a mixture of limestone and iron ore is burned in the blast furnace. The iron ore contains the silica and alumina, which are found in the clay element of the mixture used in making Portland cement. This slag is suddenly cooled, dried and mixed with about one-fourth part of slaked lime, and then the mixture finely ground to form the cement.

Two plants in the United States make cement from slag material by a process similar to that of Portland cement manufacture, that is, the mixture of slag and limestone is calcined to a clinker. One of these, in Pittsburg, uses the granulated slag, mixed with compact limestone; this mixture is finely ground, then calcined in a kiln to a clinker, and ground again, just as in the case of Portland cement. [The other plant, in Chicago, uses a similar process.—ED.]

For works requiring an early and final strength, Portland cement is usually specified by the engineer. The attempt to use under such specifications certain cements, called Portland cements, but made from a mixture of slag sand and slaked lime, has led to a dispute. On one side we find ranged those who claim that an essential feature of production of a Portland cement is a calcination or roasting of a certain artificial mixture of carbonated lime and clay to a clinker, and subsequent grinding to a powder. On the other side we find those who insist that the burning to a cinder of the limestone and other material of the blast furnace furnishes a material which, chemically, is nearly a proper mixture for a Portland cement, and that the subsequent correction by addition of a slaked lime paste does not, from the point of view of a definition, involve an error in the case of those who call this product Portland cement.

There are two ways of regarding the dispute. First, from the point of view of a descriptive term it is well to have a separate name for two products which are different in their mechanical and chemical properties. If we desire a sidewalk cement, we should not specify the material by any name which will involve a cement made by the second process above described for slag material, involving no calcination. Nor should we shut out a product like the Pittsburg product, or a similar product made in Chicago.

Second. From the point of view of historic origin it has been pointed out that the original patent for Portland cement involved a double calcination; first of the limestone, then of the mixture of this calcined limestone and clay. So strictly speaking our modern Portland cements have no right to succession to the term Portland.

The cements made by the first process have, however, the right of possession to this term Portland. It would then seem the part of wisdom to divide the cements of this country into three classes—natural, Portland and slag.

Natural will include those made by roasting and subsequent grinding of an argillaceous limestone (a natural mixture of limestone and clay).

Portland will include those made by calcining to a clinker and then grinding an artificial mixture of the proper proportion of limestone (or marl or chalk, or clay-bearing limestone) and clay (or slag sand). The slag cements will include those made by grinding a mixture of pulverized granulated slag and slaked lime paste, which mixture has been made without applied heat.

In the paper below this understanding of the term "slag cement" is intended.

This matter is somewhat important as at least four brands of slag cement as described above are on the market as Portland cements. To ask for a definite classification is not to find fault with slag cements. They have a distinct and high value for many engineering works. Let engineers write the specifications and manufacturers put out their product on the same nomenclature.

The definition of Portland cement above referred to is in conformity with the specifications of the German association of cement manufacturers, the French Ponts et Chaussées, Swiss government, Austrian engineers and architects' association, Russian Minister of Roads and Railways, and recent specifications of the United States engineers.

MM. Brull and H. Henry, in a communication to the Congress for Unification of Tests of Materials before the Paris Exposition, July, 1900, have given information concerning the development of the manufacture of slag cement, from which communication the following facts are mainly derived:

In 1898 thirty-six million tons of slag were produced in connection with the manufacture of iron. Many futile attempts have been made to use that by-product. Successful use has been instanced in railway ballast, molded blocks for engineering structures, such as sea walls and embankments, and mineral wool.

In 1737 Belidor in his Architecture Hydraulique has noted that a mortar could be made of pieces of hard brick, splinters of rock and ground blast furnace slag mixed with fresh slaked lime. At the beginning of the century Vicat had noted that certain slags had the properties of pozzuolana. (Pozzuolana is a volcanic lava which, when mixed with hydraulic lime, forms an hydraulic cement. "Puzzolan" is an imported slag cement used extensively in St. Louis.)

The utilization of slag, however, was not attended with great importance until in 1861 Langen, a founder near Troisdorf on the Rhine, discovered that the slag could be granulated by sudden cooling. Instead of the solid mass of cooled slag, a slag sand could be produced. The effect of this granulation on the pozzuolanic properties of the slag was soon noted. In 1862 at Osnabruck the application of this granulated slag to the manufacture of cement was attempted and the subsequent use of this slag included chiefly the formation of bricks and molded stones by a mixture of this slag sand and slaked lime, a process which has extended itself to many countries.

About 1880 the process of making slag cement on a commercial scale by a cold mixture of granulated slag and slaked lime was inaugurated in the canton of Berne, Switzerland. About the same time certain manufacturers of Portland cements in Germany began to mix a ground slag sand with their product with the result of increasing its strength. It is said that such mixture up to 2 per cent is not harmful and is practised at the present day. The sophistications became so general in Germany and England that protests were made agains. the practice, adulterations of 30 per cent having been found. The manufacture of slag cement spread rapidly, and at one time there were nine mills in France and twelve in Germany. At the present time, according to MM. Brull and Henry, there are the following mills in operation:

Country.	No. Works.	Production (tonnes of 2,204.6 lbs.)
France	10	85,000
Belgium	5	....
Luxemburg	2	....
Switzerland	1	....
Germany	12	180,000
Austria-Hungary	3	100,000
Spain	1	....
Russia	1	....
England	2	....
United States	4	....

These statistics do not include mills which roast the product in a kiln. Certain mills in Germany and two in the United States have lately transformed or built mills to manufacture this roasted product.

While these statistics are given in the paper of MM. Brull and Henry, it is to be noted that in a consular report to the State Department, dated 1895, the statement is made that the slag cement mills are gradually closing down, there being but one mill in Germany, one in Belgium and three in France. This report conflicts with the statement of the paper of MM. Brull and Henry, quoted, and with the account in that paper of the universal and successful use of large amounts of the product in France.

In the United States there are in the author's knowledge nine plants making cement from slag materials, two of these employing a roasting process.

In France (paper of MM. Brull and Henry) the use of slag cement is admitted for bridges and roads, railroads, mines, municipal service. It is allowed by the Administration of Roads and Bridges in hydraulic works; was used in dry dock at Boulogne; used in Metropolitan Railroad of Paris; is used in important bridges and tunnels.

A mixture of slag cement and granulated slag is made into bricks, molded stones, tile pipes. It is said that 60 parts of lime are used by volume with 250 to 300 parts of slag sand to form the bricks. The pipes withstand a pressure of 71 pounds per square inch and are used in sewers. Pipes are made of a stiff mortar of silicious sand and slag cement.

This cement is not recommended by the manufacturers in this country for such work as sidewalk work, where it is subjected to the influence of the atmosphere when spread out in thin sheets, but it is recommended for foundations, whether for streets, bridges, buildings, etc.

This paper does not pretend to give a detailed account of the process of manufacture. Briefly described the process is as follows:

1. Granulating the slag.
2. Drying the slag.
3. Mixing with desired per cent of slaked lime.
4. Grinding mixture to powder.

In some cases the slag is ground before being mixed with the slaked lime.

The stream of slag may be run into water, or a stream of water may be brought into contact with the slag as near the outlet as possible; or the slag may be run from the furnace to a trough where a stream of water is flowing. The result is sand, like broken pumice stone, or thin shell pieces of pinkish color, containing 30 per cent of water, or more.

Drying the slag sand is accomplished in a rotary cylinder with inclined axis heated by an interior or exterior flame, or by spreading the sand on sheet iron driers which are slowly passed through a heating chamber, or else in a vertical chamber with inclined runways of reversed grade, down which the slag runs and is dried.

The limestone is slaked in the mill and mixed with slag in a ball mill.

The materials are ground to an impalpable powder by the ordinary methods of cement manufacture.

The appearance of the slag cement is characterized by a delicate lilac color, in some cases almost white. When cement is made from slag by a process involving roasting, the cement is of a dark color like that of ordinary dark colored Portland.

It has not the coarse or gritty feeling which characterizes most Portland cement. It works fast, sets slowly, and passes ordinary tests for permanence of volume.

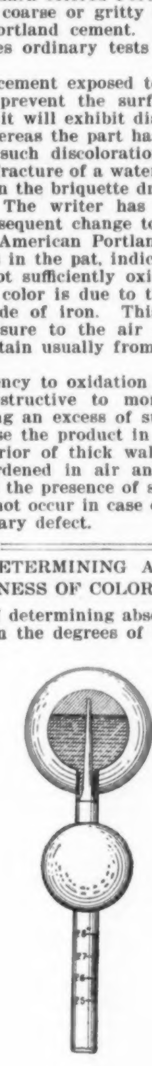
A part of the cement exposed to the air has to be well covered to prevent the surface from cracking. After drying out it will exhibit discolorations, yellowish or brown, whereas the part hardened under water will not exhibit such discolorations. The characteristic color of the fracture of a water-hardened briquette is green, but when the briquette dries out the fracture becomes white. The writer has noticed this green color, with a subsequent change to white, in the case of a well-known American Portland cement, and also the discolorations in the pat, indicating slag adulteration, or else a not sufficiently oxidizing flame in the kiln. The green color is due to the presence in slag cement of sulphide of iron. This sulphide becomes oxidized on exposure to the air and changes color. Slag cements contain usually from 0.5 to 1.5 per cent of sulphides.

It is this tendency to oxidation on exposure to the air which is destructive to mortar made of slag cements containing an excess of sulphides and makes it necessary to use the product in underground situations or the interior of thick walls. A parallel test of briquettes hardened in air and water should be made to check up the presence of sulphides. This disintegration does not occur in case of all slag cements; it is not a necessary defect.

* From a paper presented before the Indiana Society of Engineers.—From Municipal Engineering.

METHOD OF DETERMINING AND EXPRESSING THE FASTNESS OF COLORS TO LIGHT.

WITH a view of determining absolutely and expressing with precision the degrees of resistance of colors



BELLANI'S ACTINOMETER.

to light, the author proposes to measure the insolation which they are capable of withstanding up to the time when their fading may be said definitely to commence, by means of the vaporization actinometer of Bellani, as modified by Descroix (see figure).

This consists of a bulb of dark blue glass, about 0.045 m. in diameter, attached to a graduated colorless glass tube, upon which is blown a second bulb of the same size as the first. The colored bulb is filled to the extent of two-thirds of its capacity with ethyl alcohol (90 degrees) and is inclosed in a clear glass bulb, a vacuum being produced in the intervening space. The air is exhausted from the interior of the apparatus, which is thus completely filled with the alcohol and its vapor.

The samples of colors, the fastness of which is to be ascertained, are exposed to light under the same conditions, side by side with this apparatus. The quantity of alcohol which is vaporized during the exposure is noted daily, the apparatus being inverted, after the reading has been taken, in order to replace the alcohol in the colored bulb and so reset the apparatus for use. This is continued until the colors commence to fade. The amount of alcohol which distills over during this time is expressed in terms of units of thermo-actinicity, as measured by the apparatus, which it is proposed to name *photes*, a phote being the quantity of radiant heat required to maintain during one hour's time a difference of 17 deg. C. between the two thermometers in Arago's actinometric apparatus, this difference being found, by calculations based upon observations, to be the total effect of the sun's radiation outside the terrestrial atmosphere.

Each degree C. of difference between the temperatures shown by these two thermometers corresponds,

in spring and summer, with 0.145 — 0.146, and in autumn and winter with 0.140 c.c. of distillate received in the vaporization apparatus. In practice it is recommended to use a *decaphote* as a convenient measure.

When a prolonged insolation of a color is required, the degree of fastness of this, or the number of photes needed to cause it to begin to change, may be approximately ascertained from the tables of actinicity compiled by Descroix. These give the mean actinometric degrees, for several days in each month in the year, between the latitudes 42 degrees N. and 51 degrees N. in clear weather. The results obtained by means of the actinometer may in most cases be controlled by means of them.—P. Dosne, in The Journal of the Society of Chemical Industry.

SEISMOLOGY IN JAPAN.*

The chief interest attached to the publications mentioned below is the fact that while giving us an insight into the attitude taken by the government of Japan in regard to seismology, they form an important link in the history of the modern development of that subject.

On February 22, 1880, a rather severe earthquake so far excited the curiosity of the inhabitants of Tokyo and Yokohama that, with the object of studying such tremblings, a Seismological Society was founded. This society existed for twelve years and published twenty volumes. The usefulness of its work, attracting the attention of the Japanese government, led to the establishment of a chair of seismology at the Imperial University, and the organizing of a bureau which now controls nearly 1,000 observing stations. The next great stimulus that seismology received was the terrible disaster of October 28, 1891. Ten thousand persons were killed, more than fifteen thousand were wounded, and thirty million dollars' worth of property was destroyed. A comparison of the buildings which remained standing with those which were shattered and those which were utterly ruined indicated that something might be done to minimize such disasters, and to accomplish this, by virtue of an Imperial Ordinance, on June 25, 1892, an Earthquake Investigation Committee was established. This body consists of some twenty-eight members selected from among the best-known engineers, architects and men of science in Japan. Two well-known names—Prof. D. Kikuchi and Dr. F. Omori—appear as president and secretary. The *modus vivendi*, which can be seen in the Parliamentary Budget, seems to have an annual variation of from £1,000 to £5,000. Among the various investigations which this committee proposed to undertake we find the following:

To collect documents relating to seismology and volcanology; to draw up a statistical account of seismic phenomena in Japan, such, for example, as might be required by insurance companies whose risks extend to disasters caused by earthquakes; to conduct geological researches bearing upon seismology; to extend our knowledge respecting the nature of earthquake motion; to determine the velocities with which earthquakes are propagated from point to point; to make observations on changes in the vertical and earth "pulsations"; to compare the movements resulting from given earthquakes as recorded on the surface of the earth and at depths which are comparable with the depths to which the foundations of buildings may be carried; to extend observations on the variability of magnetic elements, there being reason to believe that these may hold a certain relationship to seismic activities; to observe changes in temperature at great depths; to determine strength constants for building materials produced in Japan; to measure accelerations and maximum velocities necessary for the shattering, overturning or projection of various bodies, among which no less than sixteen types of model houses are specified; to erect buildings specially designed to resist earthquakes; to study the effects of earthquakes on modern construction; and, generally, the committee undertook to make any investigation which may ultimately result in reducing the loss of life and property which so frequently accompanies violent earthquakes.

Although only nine years have elapsed since this elaborate programme was formulated, every item in it has received serious attention.

From Volumes III. and IV. we see that Profs. Tanabe and Mano have worked at the strength constants of building materials, and investigated the effects of several earthquakes upon tall chimneys. Dr. B. Koto has handed to the committee twenty-two papers on geological subjects connected with seismology and volcanology. Dr. H. Nagaoka gives a paper of intense interest to all physicists on the determination of the elastic constants of rocks; while the well-known professor of seismology, Dr. F. Omori, contributes six papers, each of importance to seismologists, and for the most part indispensable to those who have to construct in earthquake countries.

Volumes V. and VI., which contain the analysis of the diagrams of 246 earthquakes observed in Tokyo between July, 1898, and December, 1899, are entirely from Dr. Omori's pen, and although we may not concur in all the results he sets before us, seismologists in general must thank him for the vast quantity of material which he has brought together and systematized for their consideration. For the earthquakes which originated at great distances from Japan, so far as possible each seismogram has been divided into parts which succeed each other in the following order: "First preliminary tremors," in which waves of 4 seconds period are superimposed upon those of 8 seconds; "second preliminary tremors," with periods of 8 seconds, and accompanied by undulations of 14, 25 and 66 seconds period; "the principal portions" of the earthquake, which is divided into three phases also dependent on period, and finally the "end portion," in which period is fairly regular. The regularity of the terminal vibrations may, as Dr. Omori remarks, be explained on the assumption that different portions of the earth's crust have particular periods of free oscillation. The discussion of these various types of earthquake motion is based on the assumption that the waves recorded are *horizontal movements, and not tiltings of the ground.*

One observation which led Dr. Omori to take this view is that he has obtained seismograms which show that the amplitude of motion depends upon the multiplication ratio of the writing pointers attached to his pendulums, and not upon their sensibility to tilting. In addition to this he points out that if the undulations recorded were due to tilting, then the accelerations involved are such that our sense of feeling should be affected, which is not the case. Since Dr. A. Cancani, in 1893, drew attention to the fact that calculations based on a knowledge of the period, velocity and maximum tiltings of these unfelt undulations led to the conclusion that the inhabitants of the world were raised and lowered two or three feet hundreds of times per annum and had never observed the same, seismologists have regarded with suspicion the elements in the calculations leading to these results. Notwithstanding this, when we have so very much evidence of turbulent wave-like motion in and around epifocal districts, and evidence of repeated tiltings at distances of several hundred miles from the same, it is difficult to escape from the conclusion that similar but slower period movements may be propagated, like a swell upon an ocean, to very distant places, and seismographic pendulums be caused to swing.

Dr. Omori has certainly thrown new light upon the nature of the large waves, and it does not seem improbable that investigations carried out upon other lines may, if not completely at least partially, confirm his views.

A more debatable subject touched upon relates to paths followed by earthquake waves through the earth's crust. Because the velocity of the quick period phase of the large waves nearly equals that of local earthquakes, it is assumed that the former, like the latter, are propagated along the surface of the earth's crust, while waves which precede them travel at some small depth in the same. Inasmuch as the first preliminary tremors have, at a given station, a duration proportional to the arcual distance of this station from the origin of the earthquake, Dr. Omori thinks it likely that they are transmitted along paths nearly parallel to the surface of the earth, and at a probably constant depth.

Several sections in Vol. V. refer to subjects which are not seismic, although they are of great interest to those engaged in certain branches of physical research. For example, references are made to the effect of slight loads upon masonry structures, while "oscillations of the ground," whose origin is not seismic, are discussed at some length. That we have for years past been acquainted with movements of pendulums and balances not proper to those of the instruments themselves, which may continue for hours or days, suggests the question whether we are not here being re-introduced to an old enemy in a new dress. Are these movements due to those of the ground or to local movements in the atmosphere? Can Dr. Omori assure us that similar instruments, placed in different rooms or under conditions which are different with regard to temperature and ventilation, behave similarly? If this be the case, then the distinction which has so frequently been drawn between "pulsations" and "air tremors" will be more clearly established. In a stable at Shide "air tremor" effects are, at certain seasons, frequent, while at times pendulums with a 15 seconds period will yield diagrams showing that they have been moving regularly with a period of two or three minutes. In an adjoining coach-house these movements are absent, and similar phenomena are common to Tokyo and other places.

What has here been said indicates the nature of the work now in progress in Dai Nippon, a complete account of which is to be found in thirty-two well-illustrated quarto volumes, which, unfortunately for Europeans, are written in Chinese characters. These volumes are with but little doubt one of the greatest storehouses extant of information relating to practical seismology, and as such it is to be hoped that an abstract, or at least a table, of their contents may be published in a European language.

As an example of their value we may select Vols. XXII. and XXV., referring to an earthquake which in 1897 devastated Northeastern India, and cost British investors and taxpayers several millions sterling. The first of these is by Dr. T. Nakamura, an architect, and it contrasts those forms of structure which withstood the effects of the earthquake with those which failed. The second, which treats of railway and bridge construction, is by Mr. T. Koyama, a railway engineer. These gentlemen are two out of four who were sent to India by their government for the purpose of increasing their own extensive knowledge as to forms of structures most suitable for earthquake countries. On this occasion, as in others, special men were selected for special work, with the result that not only has Japan profited by disasters of this character, but she has become a teacher of nations in practical seismology, and we, among others, may offer her thanks and congratulations on her efforts to save life and property.—J. Milne, in Nature.

* Publications of the Earthquake Investigation Committee in Foreign Languages. No. 3, p. 103; No. 4, p. 141; No. 5, p. 82; and No. 6, p. 81. (Tokyo, 1900-1901).

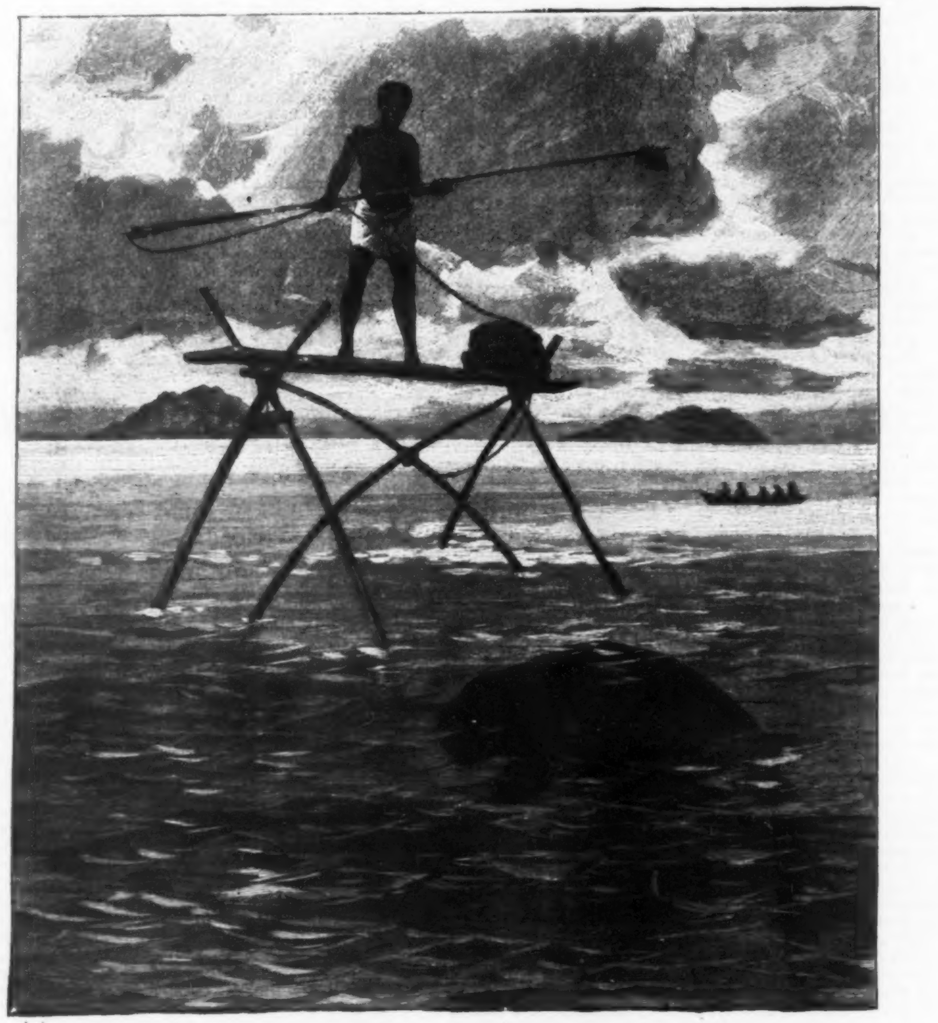


Fig. 1.—A TORRES STRAITS HUNTER AND HIS PREY.

DUGONG HUNTING IN THE TORRES STRAITS.

Why zoologists call the fat, unwieldy dugong a "siren" and why sailors term it a "sea cow," will never be known. These finned Sirenians certainly resemble cows as little as they resemble the mythological maidens who enticed the Argonauts. There are only four existing species of Sirenians, all found in the tropics. The Arctic variety (*Rhytina*) became extinct hardly fifty years after its discovery in 1741. Soon the same fate will overtake the dugong of the Malay Islands. The habitat of this threatened animal extends from the Red Sea and the eastern coast of Africa eastwardly to Salamo and Palau Islands, covering the entire Indian Ocean. In this vast hunting ground many sea cows are still to be found, particularly along the southern coast of New Guinea and in the Torres Straits.

The enormous coral reefs of this region fully answer the needs of the harmless dugong. In this inexhaustible pasture, with its great crop of sea weed, whole herds numbering from 30 to 60 dugongs were seen often enough thirty years ago. Now, according to the Illustrirte Zeitung, it is rarely that a poor half dozen "cows" ever lift their heads above the surface of the water in sight of a Malay or Papuan.

On account of its most palatable meat and fat the animal forms a staple article of food among the

natives of the African and Malay coasts. The awkwardness and harmlessness of the dugong, its stupidity, and almost trusting nature render its capture a matter of no great danger. No greater difficulty is presented than the discovery of some pasture ground which it frequents at night time. The weapons of the chase are either nets or harpoons.

Along the southern coast of New Guinea the Motu of Port Moresby are known for their skill with the net. Among them the hunting of the dugong is traditionary; for the "Rui," as the animal is called, plays no small part in the native mythology. In order to propitiate the "Balau," or the good spirit who presides over the hunters of the Rui, the dugong's capture has become associated with a series of interesting superstitions. Even the man to whom the task of the making of the dugong nets is assigned must follow certain tribal rites which are as old as the capture of the dugong itself. During the performance of his duties, the netmaker is "tabooed." He may not leave his hut, may associate only with his assistants, and must eat and speak as little as possible. Still more rigid rules must be followed when the net has been finally completed and the men are ready to start on the hunt. Carefully several large sail canoes (Lakatoi), each carrying from 12 to 15 men, are fitted out. When the hunters set out the entire community is tabooed. Silence, strict silence, is imposed upon all. Women and children must withdraw to the woods; for the mere sight of a woman will destroy every chance of success. During the journey and during the setting of the net, absolute silence must also reign. Even the leader of the party is forbidden to speak; his orders are conveyed only by signs. With the capture of a Rui or merely of a turtle the spell is broken.

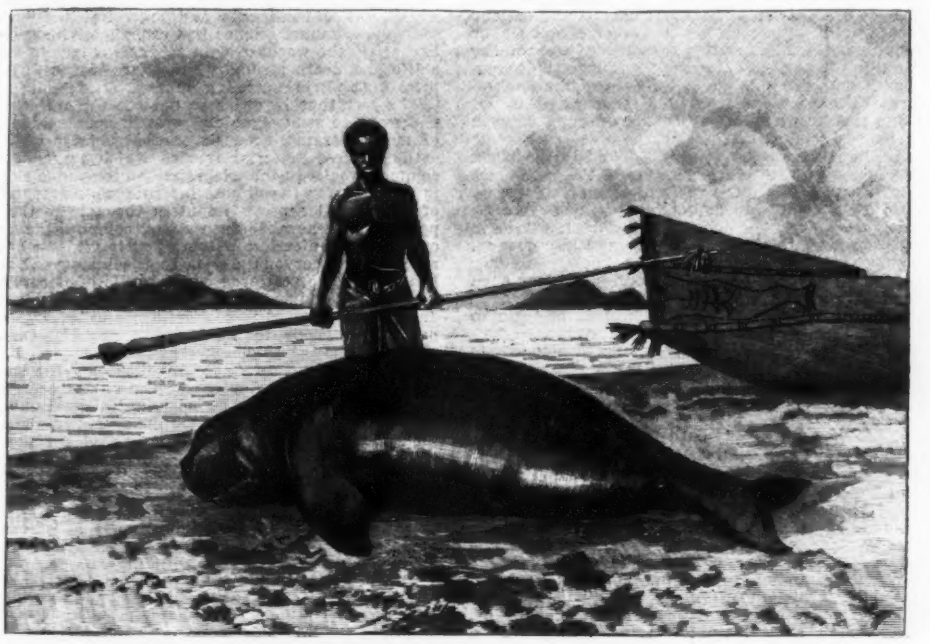


Fig. 2.—A DUGONG HUNTER OF TORRES STRAITS AND HIS PRIZE.

Fig. 3.—MOTU OF PORT MORESBY WITH A CAPTURED DUGONG.

If the hunters have been successful a long pole bearing a bast fiber flag is set up in the bow to proclaim from afar the welcome tidings to the tribe. Owing to its great size and weight, the captured Rui is usually cut up immediately after landing. Our third illustration shows a portion of an animal split longitudinally in accordance with the time-honored custom. The picture is otherwise characteristic of the habits of the Motu. Besides the pile structures, pots and drums which figure in the daily life as well as in the religion of the tribe, the man seated to the left is of particular interest. The pipe which he is smoking is the so-called "baubau," found among most of the New Guinea tribes. The pipe is a bamboo reed, in the lower end of which a cigarette is inserted.

Perhaps the most ardent and skillful dugong hunters are the islanders of the Torres Straits and the coast tribes of New Guinea, extending from the Fly westwardly to the Morehead River, a region in which the "Dungal" or "Dangal" as the creature is usually called here, is still frequently seen. Instead of nets, harpoons are used. A harpoon is a very carefully worked round, hardwood shaft ("Wap") about 15 feet in length, provided at its upper end with cassowary feathers, and at its lower end with a loosely mounted harpoon ("Woioro"). Formerly the harpoon was made of bone or hardwood; nowadays iron is used, preferably a triangular file, the temper of which has been drawn, so that a series of barbs can readily be made in the metal. A "Wap" is a precious thing in the eyes of the native, and in value is equaled only by a large canoe or a woman.

The dugong is either stalked or killed in ambush. In stalking the animal the canoe is skillfully brought so closely to the game that the man in the bow can readily hurl his spear.

When the animal is to be killed in ambush a light framework ("Nät") of bamboo is built on the reef of some feeding ground at low tide. Upon this framework the hunter takes his station at night-time. As a talisman a crudely carved miniature figure of a dugong is hung up. To the end of the harpoon a line is secured some 325 feet in length, coiled at the feet of the hunter. As soon as the dugong approaches the framework the hunter leaps into the water, hurls his spear, grasp his line, and waits for the arrival of his companions in a near-by canoe. The thrust of the harpoon or spear is usually not deadly. A rope is therefore thrown around the tailfin, and the creature held under water and drowned.

The methods of hunting the dugong which we have described may now be considered somewhat antiquated, for the natives are beginning to use the swift boats of pearl divers. The change has been brought about largely by the reason of the fact that the pearl divers have long made a practice of killing dugongs and selling the meat, salted, smoked or otherwise preserved, to the Eastern Australian Colonies. The fat of the animal is very extensively used for medicinal purposes.

The relentless methods pursued both by the natives and by pearl divers must soon result in a total extermination of the dugong. Protective measures should be adopted. Only a single variety of a particular species is still left, and that variety should be preserved at all hazards.

THE SOCIAL SERVICE OF SCIENCE.*

The extent to which society may be considered as an organism is still, I understand, a matter of controversy with sociologists, but without awaiting its adjudication, we may surely make use of a simile as ancient as that of the Apostle who spoke of individual Christians as members of one body, or as that of the wise old Roman who taught the mutinous plebs the parable of the body politic, all of whose members were nourished by the well-fed patrician belly, and consider together this evening the special function of science in the body social.

It may at least supply a convenient means of classifying the various services of science to the common weal, if we consider it not as a distinct corporal member, but rather as a growth force, ever accelerating the evolution of society, providing it with organs of defense, increasing its muscular energy, and perfecting its systems of circulation and communication. And if to these services we add the reaction upon the social mind of the physical environment which science has provided, and the direct influence of scientific truth, we shall then have sketched at least the main functions of science in social evolution.

Among the first services to society which our biologic analogues suggest is that of defense. Under the growth force of science the body social has accomplished an evolution similar to that which brought the vertebrates, assumed to have been at first naked and defenseless, to the stage of the armored fishes of the Devonian, and which in the Tertiary changed tooth to tusk, nail to claw, and frontal boss to horn and antler.

Prescientific society was destroyed largely because it had attained no adequate means of defense. It is safe to say that had the Roman legionaries been equipped with Maxims and Mausers, the episode of the Hun and Vandal invasions of Southern Europe would have been indefinitely postponed.

Modern society, which science has armed with the most terrible of death-dealing weapons, whose explosives are brought from the laboratory of the chemist, whose immense guns are fired at ranges which require the rotation of the earth to be taken into account, and with a precision which considers the difference in density of the air at the top and at the bottom of the bore, whose war ships are armored with the latest discoveries of metallurgy, their turrets turned and their guns loaded and trained by the electric current, and their evolutions directed by invisible vibrations of ether—surely a society thus armed has nothing to fear from any barbarian peril, be it yellow or be it black.

Civilization is safeguarded by science not only from the irruption of savage hordes, but also from the invasion of disease, from such epidemics as that which in the middle of the fourteenth century swept away more than half the population of England, and twenty-five millions of people in Europe. To-day when the plague appears in San Francisco or in London, it excites little more alarm than Gibraltar would feel at the assault of the Moor. By the simple remedy of vaccination science has saved in each generation of the century more lives, it is said, than were lost in all the wars of Napoleon. Among civilized nations within the last five centuries the death rate has been so lowered that the average duration of human life has nearly doubled. Medicine no longer attacks disease with charm, exorcism and nostrum; she obtains her weapons from the armory of science. From chemistry she brings a pure materia medica, new compounds, new processes, new methods of diagnosis, and anesthetics which have made surgery painless. From physics she obtains the appliances of electro-therapeutics, a delicate cautery, and the Röntgen ray, used by physicians in almost every town of size in Iowa within less than half a decade of its discovery.

The debt of the healing art to the sciences of the biologic group is so vast that I will select but one, bacteriology, for illustration. It is to no lucky chance that the discovery is due of man's most subtle and deadly foes, the bacteria. The work of Pasteur, the pioneer, and of his illustrious followers, is marked by the most thorough and painstaking investigation, and the most searching and rigid tests. It is by the application of the scientific method that the enemy has been unmasked, his ambuscades and chosen places for assault discovered and rational methods for his destruction demonstrated. It is men of science who have organized the victory of medicine to-day over diphtheria, rabies and the plague, over the venom of the snake and all the diseases to which serum theraphy is successfully applied. And where the bacteriologist cannot as yet supply a specific for disease, he can often point the way to its prevention. When the access to the human system of the germs of typhoid and cholera by drinking water is demonstrated, Hamburg builds its filter beds at a cost of $2,280,000 and Chicago expends $33,000,000 upon the drainage canal. And so with the great white plague, tubercular consumption. Science has proved the lurking places of the contagium in the sputum, and its carriage in the air we breathe, and reinforced by the high moral sense of our people, she is fast making it as impossible for the consumptive to spit on the pavement unhindered as for the smallpox patient to walk unarrested down our streets.

And who can estimate the number of lives now saved in each generation by aseptic surgery? So long as putrefaction was held, as by Liebig, to be due to the action of the oxygen of the air, no remedy for it could be suggested; but when once its bacterial origin was proved, the step was inevitable to those precautions

* Address of the retiring president, Iowa Academy of Science, Des Moines, December 26, 1900.—From Science.

which have rendered safe and successful the marvelous operations of modern surgery.

Micro-biology extends her ægis also over the herds and crops of man. She destroys the insect enemies of our grain fields and protects vine and fruit tree from blight and mildew. She saves the silk-worms of Europe from the plague threatening their destruction, and the flocks and herds of America from some of their most destructive diseases.

Thus science performs a service to society incalculable in its value. It defends it from foes both within and without the gates. It prolongs life, assuages pain, lessens disease and makes death a euthanasy. So notable have been its victories during the century that we may almost prophesy the coming of the time when the only deadly bacillus remaining will be that as yet undescribed species, *bacillus senectutis*, or at least when only sufficient disease will be left on earth to provide for a speedy and beneficent extirpation of the unfit.

Viewing organic evolution from the angle of the physicist and considering the animal body simply as a machine for the transformation of potential into kinetic energy, the secular process sums itself up in the production of better and better machines. From the fish of the early Paleozoic, on to the amphibians of the Carboniferous, the reptiles of the Mesozoic, and the mammals of the Tertiary and of the present, we have a series of higher and higher organisms, each capable of doing more work and better work than its predecessors.

It is possible to construe social evolution in the same terms. Primitive society was weak. The energy at its disposal was that only of the human body, the beast of burden, and, to a limited extent, of wind, water and flame. So feeble was the ancient state in what may be termed its musculature, so little could it utilize the forces of nature, that it may be compared with a stage of organic evolution preceding that of the vertebrata, that, let us say, of the turbellarian worm, "whose arrangement of muscles," biologists tell us, "is far from economical or effective." *

In comparison modern society may be likened to one of the higher mammalia, such as the tiger or the elephant, which can not only take up from nature the maximum of energy, but can also apply it in varied movements and a highly complicated conduct.

Consider the vast stores of energy which society has to-day at its disposal. The steam power of the United States alone equals the day labor of one hundred million men. Behind each man, woman and child of the nation stands more than one automaton of steel, with the strength of a man, but with manifold his capacity for productive labor. In carding, for example, fingers of steel do in half an hour what the unaided workman of a century ago could not have accomplished in less than eight months. Society finds in machinery a tireless hand capable of performing the mightiest and the most delicate of tasks with equal ease. It strikes with the steam hammer a blow of 2,000 tons, and it rules the Rowland grating with its 48,000 parallel lines to the inch.

Consider also the new induement of energy which science has bestowed upon society in the gift of electricity, a power capable of the swiftest and most ready transmission, of infinite subdivision, and of the greatest known intensity of concentration. And how varied is its functioning. In mine and quarry it picks and drills and fires the blast. At the wharf it lifts and loads and carries. In the factory it forges, casts, welds and rivets. In the home it shines in the most healthful light yet made by man. In electrolysis it produces a hundred substances of value, such as the caustic alkalies, bleaching powder, chloroform, the chlorates, and aluminium, the metal perhaps to give name to the new century. From the refuse of the mine it extracts millions of dollars worth of the precious metals. It surfaces the common metals with those more beautiful and precious, and copies infallibly the engraved plate of the map and the type-set page. In the electric furnace it creates new compounds, calcium carbide the source of acetylene gas, carborundum the abrasive of the future, and calcium nitrate, which promises a new source of nitrogen to fertilize and renew exhausted soils everywhere. It aids in the synthesis by which the chemist builds out of the inorganic the dye, the perfume, the essence, and soon perhaps the food, which nature builds only by the processes of life. Such are some of the functions of the new muscular system with which electrical science has equipped the body social.

It is not claimed that pure science is the only factor in industrial progress. Invention, business sagacity, and many other causes co-operate. But the work of science is essential, fundamental, creative. How far unaided invention can go may be seen in China. Here is a people once pliant of intellect and inventive. As artificers they still are given high praise. But Chinese invention, destitute of all scientific foundation, stopped with the firecracker, the movable type and the directive loadstone. It could not possibly go on to the Lyddite shell, the Hoe printing press, and the compass of Lord Kelvin. Invention is applied science, and as has been well said, science must first exist before it can be applied. Between the scientific investigator, the discoverer of principles, and the inventor who applies them, there need be no jealousy. If the last has the popular fame and the financial reward of the present, it is often to the first that the future belongs, and, in any event, in the words of the generous Schley at Santiago "There is glory enough for all." And after all why should the name of science be refused to that vast body of knowledge, classified and tested, which is in daily use in the laboratories of the industries of the world.

But to science even in its most restricted sense the debt of society is incalculable. It has evoked those good genii, steam and electricity. Watt was led to the invention of the steam engine, not by a boy's glance at his mother's teakettle, but through the discovery by Black of latent heat and after two years of profound study of such abstruse problems as the specific volume of steam and its law of tension under varying temperatures. And the improvements in the steam engine, which since the fifties have more than doubled the speed of the piston, while saving at least one-fourth of the fuel, have been made under the guidance of Joule and the mechanical theory of heat. In the matter of the advantage of superheated steam and high pressure, theory still seems to outrun practice.

* J. M. Taylor, "Whence and Whither of Man," Morse Lectures, 1895, N. Y., 1896, p. 47.

In electricity the mechanic can take no important step beyond the scientific discoverer. How happy was the thought which designates the various units of electricity by the illustrious names of the masters of research: volt, in honor of the professor in the University of Pavia, who, one hundred years ago, gave the world in his crown of cups its first effective reservoir of the new power; ampère, the name of the professor of physics in the College of France, founder of the science of electro-dynamics; ohm, in memory of the professor of experimental physics in the University of Munich, discoverer of the law of the strength of the electric current; and farad, in honor of the greatest of them all, Michael Faraday, professor of chemistry in the Royal Institution of England, the prince of experimenters, whose researches, resulting in the dynamo, connected the industries of the world with the first economical source of electrical energy.

Illustrations of the dependence of industry on pure science are everywhere at hand. When, as an amateur in photography, I take up a package of eikonogen or hydroquinon, the label with the name of one of the great aniline factories of Germany, at Elberfeld, Mannheim or Berlin, reminds me of the debt of the *Farbenfabriken* to men of research. To the chemist is not only due the discovery of my developers, and of such other by-products as antipyrine, cocaine, saccharine and vanilline; it was he who first found in the black amorphous coal tar, the former refuse of the gas works, those brilliant crystalline dyes which have so largely replaced other colors in the dye vats of the world. So far as I am aware, no monument has been raised to these discoverers, to Hoffman, Graebe and Liebermann. In a more telling way industry acknowledges her debt to pure science when a great aniline factory such as that at Elberfeld employs sixty professional chemists, and turns the attention of twenty-six of them to pure research in discovery of new compounds.

Science has thus given society command of energies of the highest efficiency. It has made the comforts of life common and cheap, it has lifted from the shoulders of labor its heaviest burdens and set free for higher social services all who are capable of their performance. It is the undiminishing fountain whence flows the world's material wealth.

The evolution of the circulatory system in the body physiologic suggests a similar development in the body social. The process which during the geologic ages slowly changed the primitive gastro-vascular cavity to the perfected circulation of the higher animals to-day, which evolved from a simple pulsating tube the powerful four-chambered heart, may at least serve as a simile to the evolution of the distributory or transportative system of modern society. So obvious is the analogy that the arteries of commerce is a phrase of common parlance. But for our purpose it will not be necessary to carry the likeness into details, to discriminate, as some ingenious sociologists have done, the various organs, such as the capillaries of the body social, or to liken the red corpuscles of the blood to the golden disks of the circulating medium. Let it suffice to show that by the application of the discoveries of science society has obtained a system incomparably rapid and effective for the distribution of power, of food and of all the products of labor.

The world is enmeshed by lines of railway and steamship. They carry the products of our Iowa farms to western Europe, to South Africa and to China. To our dinner tables they bring in return linen from Ireland, porcelain from France, cutlery from old England and silverware from New England, meats and fruits from States as distant as Texas, California and Florida, spices from the East Indies, and beverages from Japan and Java and the valley of the Amazon. In the United States alone there are now in operation nearly 200,000 miles of railway carrying each year a billion tons of freight and five hundred and fifty millions of passengers.

The carriage of power is accomplished at present almost wholly by the transportation of fuel. The value of this service may be seen by contrast with some railroadless country such as China, where, according to Colquhon, coal selling at the mine at fifteen cents per ton costs as many dollars ten miles away. But the future doubtless has in store the distribution of power as an article of merchandise. The possibility of long-distance transmission of electricity has already been demonstrated at Niagara, and the time may be near when in our cities power from coalfield or waterfall may be purchased for use in factory and home as readily as water or gas to-day.

What has been said already of the debt of industry to science in the development of its motive powers applies here equally in transportation. Permit a single illustration further of the value of pure science in the evolution of the circulatory system. Every engineer is aware of the large contribution which the steel rail has made to the success of the railway. Durable, strong and cheap, it has displaced on all our railways the weak and short-lived rail of iron. It has made possible heavier trains and higher speeds. Together with other factors it has so cheapened traction that, according to Prof. J. J. Stevenson, the coal of West Virginia is now sold at New York city for less than one-fourth the railway freight charges of a quarter of a century ago. But it is no belittlement of the laurels of Sir Henry Bessemer, the inventor who has made all this possible, to point to the fact that the success of his process, which, by ushering out the Age of Iron, and ushering in the Age of Steel, has revolutionized industry and touched every home with its beneficence, is due not only to his use of a great body of facts in the chemistry of the metals, but in especial to the utilization by Mushet of the facts regarding the influence of manganese and its relation to carbon, facts ascertained in the laboratories of science and left on record to await their use by invention at the proper time.

The mobility in the social organism so largely due to science has had far-reaching effects. It stimulates production to the utmost. It opens the markets of the world to the products of every worker. Labor has itself become mobile, and in the factory raw material from distant lands meets operatives from across the seas. It is the cause of vast migrations, such as that which has brought to the United States more than nineteen and a quarter million people since the opening of steamship routes across the Atlantic. It makes impossible in civilized lands such famines as that which in 1878 in two of the northern provinces of China destroyed more than nine millions of men. It opens to the occupation of a single homogeneous civilized commonwealth such vast areas as the Mississippi valley. To any such it would be as fatal to stop the social circulation made possible by science, as in a limb of the body to ligate the main artery. Dense populations can indeed exist wherever food can be raised in abundance, as on the river plains of China, but without the modes of distribution introduced by the science of the nineteenth century, they neither can be unified into a homogeneous community nor can they be lifted to the levels of modern civilization.

By its systems of circulation which break down all barriers, science has brought about the supreme crisis in social and political evolution. Like the epeirogenic movements which mark the crises in geologic history, which united continents and precipitated alien upon indigenous fauna, science has brought civilization and barbarism the world over in all their stages to meet in a life and death struggle, and offers to the fittest the prize of a world-encircling empire.

The fact that in order to operate the railway it is necessary to send signals at greater speeds than those of moving trains, suggests another service of science—the highest material service which it renders the common weal. In the telegraph and telephone a system is supplied for the almost instantaneous transmission of motor and sensory impulses throughout the body politic. In general terms we may compare the growth of the communicating system of society to the development of the nervous system in the history of animal life, where the scattered central cells of nature's first sketch of such a system are later gathered into ganglia, and ganglia massed into a brain connected with every part of the body by ramifying nerve filaments. Of all social organs this seems the most retarded in its evolution. In primitive society it is only the smallest groups, such as the family and the village community, which have a facility of communication comparable with that of the lowest of the metazoa. In the larger groups of the tribe and nation we find a stage more advanced than that of the hydra only after science has made possible the railway post and the telegraph and telephone.

That Morse is the inventor of the electric telegraph is a statement more veracious than that of the Vermont farmer who said that everybody knew that Edison invented electricity. But the name of the inventor of every tool of society is legion. Morse set the keystone of the arch, but its voussoirs had been built by investigators unknown to popular fame in many lands, and even the keystone was almost placed in the hands of the distinguished inventor by Henry, the great physicist. And Oersted, who in 1819 deflected the magnetic compass by a voltaic current in a neighboring wire; Arago, whose experiments with iron filings proved that this current would generate magnetism; Ampère with his suggestion of the possibility of signaling at a distance by the deflection of needles; Sweiger, who took up Oersted's experiment, and discovered that the deflecting force of the current was increased when the wire was coiled about the magnet; Sturgeon, who, making use of Arago's discovery, replaced Sweiger's magnetic needle with soft iron and thus constructed the first temporary or soft magnet; Henry, who strengthened the electro-magnet and used it with over a mile of wire to give signals by tapping a bell—all of these men, devoted solely to knowledge for knowledge's sake, are sharers with Morse and Vail in the glory of the invention of the telegraph.

And so with wireless telegraphy. In Marconi's hand this invention blazes with a sudden brilliance which attracts the attention of the world, but the torch has been conveyed to him along the line of many runners in the torch race of scientific discovery. From Clerk Maxwell, who showed the analogy between electricity and light; from Hertz, with his demonstration of electromagnetic waves; from Onesti of Fermo, and Branly of Paris, and Lodge of London, whose researches produced in the coherer an instrument capable of seeing such waves; from these and others the torch was passed on to the great inventor whose improvements in apparatus made effective the discoveries of science.

In the telephone at least four scientific principles are involved—the voltaic current, the interaction of magnetism and electricity, the temporary magnet and the microphonic action of carbon. Through this marvelous invention each master in electrical science from the time of Galvani who has aided in the elucidation of these principles, though dead, yet speaketh.

Thus we may fairly claim that to science is due in large measure the plexus of post, telegraph and telephone, by which intelligence is flashed throughout the body social even more swiftly than along the nerves of the body physiologic. And how incalculable is the service which science thus renders! Consider the extent of the channels of communication. The domestic mail service of the United States requires each year twenty-one million miles of travel. Sixty-four years ago the first commercial telegraph was built with a length of forty miles. At the close of the century there are not less than one million miles of telegraph in the United States, over which duplex and multiplex messages are carried at the same time, and the rate of transmission has risen to six thousand signals per minute. One hundred and seventy thousand miles of submarine cables moor coasts, islands and continents together. Over one million miles of telephone wires have already been strung in our own country. Boston, a typical city, measures its electric nerves at a total of one hundred and seventy million feet, and the radius of audible speech from it reached a year since, according to Iles, to Duluth, Omaha, Kansas City, Little Rock and Montgomery.

Note the saving of time and energy thus accomplished. Without leaving his desk the manager of a business is in instant communication with all his employes, and with the business enterprises in his own and other cities. The captains of industry are thus

able to command armies of a size unthought of a few decades since. So accurate and instant are the new motor and sensory nerves that the oil refineries, the copper mines, the steel mills, almost any industry that may be mentioned, can be regimented under one control, and an industrial revolution is accomplishing before our eyes.

The electric wire with the fast mail and the newspaper flash the news of the world throughout all civilized countries. When our army attacks Santiago or marches on Pekin, the public become impatient of even the interval between the morning and the afternoon paper. On the night of a national election the American public listens to the count of votes in every city and in every State. The new discovery of science, the new mechanical process, the new remedy for disease, are communicated without delay to the entire world. In commerce local prices seek the level of the world market, and the entire distributing system is as effectively controlled as are the capillaries of the animal body by the clutches of the nerves. In a theater vast as the whole earth we look down on the stage upon which is played the never-ending drama of current history.

In a still larger sphere the new organ of communication has a reflex on civilization. It makes possible self-governing communities stretching from the Atlantic to the Pacific and even the federation of the world. Bringing Washington face to face with London, Paris and Berlin, and the other capitals of Europe, it enables the great powers of two continents to arrange without delay a concert of action whose message flashes round the planet and is carried into effect at Tien Tsin and Pekin. In direct contrast unscientific China outspreads her bulk like some vast insensate vegetal growth. Under attack, even at a vital point, she can neither mobilize her armies nor even disseminate a knowledge of the danger before it is too late.

It has been said by Giddings that objectively viewed progress is an increasing intercourse, a multiplication of relationships, an advance in material well-being, a growth of population, and an evolution of rational conduct. Subjectively it is the expansion of the consciousness of kind.*

In all these respects science has been an accelerating force in the evolution of society. Increasing food supply by means of scientific agriculture, lengthening life by repression of diseases, and introducing a thousand new means of livelihood, it has made possible the extraordinary recent growth of civilized nations. It permits the population of Europe to more than double since 1800, and enables England, which in the seventeenth century men thought too small for its scanty population, to support more than 38,000,000 people in comparative comfort. It lends some encouragement to the sanguine prophecy of Albert Bushnell Hart that the Mississippi valley will sooner or later contain a population of 350,000,000.†

At the same time science has produced a heterogeneity of structure. The scientific principle discovered to-day flowers to-morrow in invention and produces the seeds of special arts and crafts. To Volta's researches in his villa on Lake Como five million men now employed in the many various arts connected with electricity owe in a measure their livelihood. In promoting the development of the complex organs of society for the handling of energy, for distribution, and for communication, science has constantly been a differentiating force.

By the same means it is accomplishing a more and more complete integration. The separate life of primitive society, the old personal independence, is gone. In the new order all social units and aggregations are interdependent. We are all members of one body. We must not ignore the purely psychic factors of social progress, but these alone could not maintain the new order apart from the physical basis built by science, itself a psychic factor. Were this support withdrawn, it would seem that over large areas now occupied by civilization, society must lapse and break into fragments fast degenerating into the state of the villages of the Russian plain, the scattered communities of the southern Appalachians or even to the pueblos of Arizona.

As we have spoken of the service of science in promoting the physical well-being of society, there remain of Professor Giddings's notes of social progress only the evolution of rational conduct and the consciousness of kind. These phenomena are involved in the evolution of the social mind. Here science acts directly and also by the reflex of the social organism. The organic unity of society is the ground for the expansion of the consciousness of kind. The social ties woven by science help to produce a wider social sympathy. Under the régime of science the barriers of the mark break down everywhere to make way for the market, and with their downfall the provincialism, indifference and hate of once separated peoples pass away. Science has created, as we have seen, a new physical environment which reacts constantly on the social mind, awakening from torpor, stimulating to greater activity, demanding a more alert attention, and a precision and swiftness of movement before unknown.

Still more directly is science creating an intellectual milieu whose influence on the social mind is as inescapable as is that of climate on the physical life. The world of our forefathers, how close its confines, how dark and shadowy, how uncertain and untrue, compared with the illimitable sphere which science now fills with her clear light. It is a universe, not a multiverse, the new world which science apperceives. It is a world of law, in which each event has adequate cause; the expression of one immanent energy operating across all widths of space and throughout all lengths of time, without loss or increment, and without variableness or shadow of turning; an eternal becoming an evolving order which comprehends the growth and decay alike of solar systems and of the humblest of living creatures. It is of this new world that the two master Victorian poets, inspired by both the scientific and religious spirit, have written:

"All's law, but all's love,"

and,

"One God, one law, one element,
And one far-off divine event
To which the whole creation moves."

The effect of these new cosmic conceptions of science penetrates every department of learning and every field of life. It revolutionizes society. It rationalizes the social mind. It has swept to the limbo of things that are not the sprites of evil which affrighted our forefathers. In this science has done a work which neither literature nor art nor religion nor ethical culture has proved itself able to accomplish. It was the pious Melancthon, the gentle scholar of the Reformation, who at Heidelberg saw in falling stars only the paths of deceitful devils, and the mandarin to-day, learned in all the ethical wisdom of Confucius, a classical scholar of the finest literary taste, still burns his firecrackers at the funeral of a friend that he may frighten away the pestiferous spirits of evil which dog the steps of men through life even to the threshold of the world beyond.

The rationalizing influence of science upon civilization needs no illustration to one versed in the literatures of the prescientific ages, to one who has read Plato's "Timæus" or Plutarch's description of the moon. And how preposterous were the theories current but a century since, such as those which saw in fossils the freak of some plastic power in nature or the remains of a catastrophe which swept away in a flood of waters the very foundations of the earth. To-day how rare and how interesting are such survivals of this almost forgotten time as the Atlantis of Ignatius Donnelly!

The theory of evolution furnishes one of the best examples of the replacement of the untruths of the past by truths discovered by science, and of their revolutionary effect. Since the discovery of the proofs of this process, man has come to know himself as never before. He understands at last the meaning of history and rewrites his texts on philology, literature and all social and political institutions. He sees, though as yet dimly, some solution to the ethical problems of sin and evil, and beholds as in a panorama the process of his creation.

It is as yet too soon to see the full effect of these new conceptions upon the social mind. Science has not yet come to its own in education, and the irrational and the unreal are far from being wholly banished from society. But more and more the care of the young is intrusted to science to train, as none other can, to be quick of eye, true of speech, and rational in thought, to bring them face to face with reality and to open to their view the widest and most inspiring vistas. Common knowledge is one of the strongest social bonds. We meet and touch in what we know. The time has been when educated men drew together in a common knowledge of phrases written in extinct languages. To-day they find this *rapprochement*, this consciousness of kind, more and more in a common training in science. In the laboratory they have measured the energy of the falling body and studied its transformation into sound, heat, light, chemism and electricity; they have tested the ray from the hydrogen atom and found its vibration the same from the flame on the table and in the light of Sirius. They have dissected the tissues of life, and have read in Nature's book the life histories of mountain, river and planet. And thus to-day they have attained to that cosmic conception, overwhelming in its sublimity, which is the best gift of science to man.

The reward which science asks for this service is the wages of going on; she asks for well-equipped laboratories, for longer courses of scientific study in schools, for the endowment of scientific instruction and research. Such foundations as the Lawrence Scientific School, the Field Columbian Museum, and the Smithsonian Institution are examples of appreciation as yet as rare as munificent. I am not aware of any such in Iowa. When wealth builds the spacious laboratory or endows a chair in science in any college of the commonwealth, it is but rendering to science her own. Each dollar earned by railway, telegraph and telephone, mine and quarry, mill and factory, farm and store, may well pay tithe to science which has made these industries possible. The gratitude for a life saved by the applications of science in modern medicine might well be generous. And yet the total gifts to scientific instruction in Iowa by men of wealth do not exceed $50,000. I am aware of the State appropriations to the scientific departments in our State institutions, and I should be glad to call them generous. At least they have given Iowa the fame of men whose work in science has achieved national recognition. But these yearly appropriations, were they many times as great, could not supply the place of the great gifts, endowments to be for all time reservoirs of power transmuted constantly into the highest social service. It is the boast of American democracy that by such votive offerings it shows appreciation of education, charity and scientific research.

As members of a guild of workers in science, let us be thankful for even the humblest place. To discover any fact, however trivial, to add anything, however slight, to the sum of human knowledge, this is to shape and dress some stone for the building of science, the home and shelter of the race. Our contribution may go to chink some crevice, or at least some master builder may find in it the keystone of an arch or the capstone of a column. But whatever its place, if our work was well and truly done it abides as a permanent service to society.—William Harmon Norton, Cornell College, Mt. Vernon, Ia.

* "Principles of Sociology," New York, 1896, p. 359.

† "Future of the Mississippi Valley," Harper's Mag., Vol. 100, p. 419.

WOMEN INVENTORS.

UP to ten years ago women had contributed but slightly to the sum total of inventions recorded at Washington. A woman's name did not appear in the list of patents granted more than three or four times a year. To-day there is scarcely a page of the official list of patents which does not record some woman's success in this line of effort. In addition to those on record, there are each year an increasing number of successful women inventors whose inventions are not patented in their own names, but bought outright by manufacturing and business firms, who themselves secure the patent. New toys, games, puzzles, articles classified as novelties, medical appliances and dress and household facilities are some of the popular inventions bought up by business firms, the inventors being glad to dispose of their rights for a fair sum.

It sometimes happens that a woman employe of a manufacturing or mercantile house invents some improvements on the machinery and methods in use by the firm. She shows the model or drawing to the manager, who makes the firm acquainted with its merits, and they arrange for the inventor for the exclusive use of the improvement. The inventor goes on quietly with her every-day work in the mill, and the public never hears of her achievement; but, encouraged by that success, she continues her experiments and keeps on the lookout for further invention.

A woman clerk in a New York store invented lately a parcel-delivery system, which netted her substantial returns. One New England mill-owner, herself an inventor, enjoys the right to several patents that represent the ingenuity of the women operators in her employ. She shares profits with the inventors, and one of the devices, first used in this mill, brings in over $20,000 a year.

Men acquainted with the field say that fully one hundred of the patents taken out by women within the last five years are yielding unusually large returns to the inventors, and that others not yet put on the market are destined to be equally successful. A law of contrariety seems to govern the chances in the matter notwithstanding, for while many of the best patents—those that show real genius and knowledge in the inventor—bring in only small returns; others, seemingly trivial, make the inventor rich. The woman who invented satchel-bottomed paper bags, for instance, was offered $20,000 for the patent before she left Washington. A simple glove-buttoner is yielding the woman inventor $5,000 a year. A patented adjustable waist-supporter has made the inventor independent. A device for opening letters has proved exceedingly profitable, and the young woman from Georgia who invented a convenient traveling-bag has made money enough to set herself up in business.

The Northwest, the Middle, and Eastern States have produced the most active women inventors. The South is behind in this regard, although the few women from that section who have made inventions have been successful. Their inventions are usually in very practical lines. An Alabama woman farmer has invented two important aids to agriculture. A North Carolina working woman has had success with a culinary invention, and a Florida woman has patented a useful car-heating appurtenance, while a Texas woman has patented a novel folding tent, and another Southern woman a finger-exercising device of value to musicians. A unique method of desulphurizing ores is the invention of a California woman, and another Western woman has patented several inventions relating to irrigation.

It is noticeable that the women inventors registered from the larger cities of the country have almost invariably patented articles pertaining to the elegancies of dress and household furnishing, while inventive faculty in the country districts and villages has been directed to conveniences and labor-saving devices in similar lines. Women from the big cities have invented unique dress-drafting patterns, novel ways for adjusting portieres and curtains, and patents relating to the various fields of art, and the manufacture of artistic goods. City women have also devised and secured patents on numerous articles for clerical use, safety envelopes, improved typewriting appliances, copyholders, etc., as well as conveniences for the artist and musician.

A number of women school teachers are successful inventors, and have patented more or less valuable educational methods and devices; also kindergarten devices and articles of school-room furniture, desks, book-rests, blackboard erasers, school-bags, etc. Women from the small towns in Wisconsin, Minnesota, Dakota, and Illinois have been prolific in inventions relating to the household arts, washing and cleaning apparatus, facilities for sanitation, garment bindings, protectors, shields, waistbands, supporters, fastenings, etc. They have invented butter-workers, plumbing appliances, dish-washers, brushes for cleaning upholstery, and compositions for kindling fires, and scores of articles calculated to lighten the burden of the housekeeper in kitchen and pantry. New England women have invented many conveniences for factory use, and a number of practical attachments and improvements that have to do with harnesses and vehicles and the various needs of the barn and garden.

Many of the patents applied for by women are rejected on the score of absurdity, but in this respect the women aspirants do not differ from the men, since, according to official testimony, more silly and impracticable inventions are sent to the Patent Office every week than can be described. Others there are accompanied by most elaborate models and drawings, but so conspicuously lacking in some vital principle that the whole is stamped as the work of a visionary with no well-founded ideas to work upon. More and more women each year are submitting practical specifications, and the failure to score success is not owing to any lack of originality, but to the inventor's ignorance of previous patents covering the same point. The fact that many minds work out the same theories along given lines is well authenticated in the experience of the Patent Office officials, and they advise every inventive aspirant, no matter how brilliant her idea, to search thoroughly the ground gone over by competitors before making a model. Disappointed inventors, like disappointed authors or artists, seldom give up the effort, and in many instances win success in subsequent ventures.

A lock with three thousand combinations is a woman's invention; also a letter-box for the outside of houses that shows a signal when there is a letter inside for the postman to collect, an invention now in daily use. Improved canteens and soldiers' camp-beds and tents are women's patents. An English woman has just perfected a most valuable apparatus for removing wool from skins by electricity. At different times women have patented inventions relating to horseshoeing, and an especially speedy and profitable process for making horseshoes was invented by an English

woman. A Swiss woman has taken out a patent in this country for aluminium solder. A Rhode Island woman has the credit of inventing an improved button-hole-cutting machine by which the distance between the button-holes is measured automatically.

Much of the activity that women now exhibit in inventive fields is attributed to their better facilities for education, the college standard that now obtains, and popular courses in sloyd and manual training. A goodly proportion of the successful inventions, however, are produced by women who have had only medium or limited advantages in this regard, but have been practical workers in the various lines of industry.

In our own country, a Mrs. Mary Kies was the first woman to take out a patent. She invented a process for weaving straw with silk or thread, and the process was first put into practice in 1809. It was six years later before any other woman secured a patent, and then it was for inventing a corset. During the next quarter of a century only fifteen patents were granted to women; these included a globe for teaching geography, a baby jumper, a stove-foot, and a sheet-iron shovel. Thirty-five patents were taken out by women in the next twenty-five years, and some of the titles sound strange to modern ears, such, for instance, as a "balloon calash for ladies." A fan attachment for a rocking-chair was got out by a woman in 1848; also a model sad-iron, and a recipe for lavender balsam. When we come down to the early sixties, an improved imitation of braided human hair is recorded as the invention of a woman; also a novel darning-last and an improved hoop-skirt.

The high schools that were opened to women in 1859 had given them insight into many things which did not specially concern women's interests, and then the civil war forced them into new avenues of thought and work. A number of Western women who took their husbands' places on the farms invented improved agricultural implements about this time. A curry-comb was one woman's contribution, and several women who went into the shoe shops and manufacturing mills took out patents on different kinds of machinery. From nursing in the hospitals, that at the time were crude and lacking in comforts and conveniences, women got practical ideas of the needs of sick-rooms and in medical appliances, and set to work to better them. After the civil war a considerable increase is noticed in the number of women's inventions, and within the last twelve years they have multiplied, as the 152 models exhibited in the government department at the Atlanta exposition served to show. That was the first occasion that any effort had been made to demonstrate woman's work in the inventive field, and since then the Patent Office has had a specially classified list of women's inventions prepared and published for public inspection.

The list of patents granted to women during any two consecutive months of the present year shows a wide divergence in the subjects that have engaged attention. A woman pupil at a New York school of embalming invented a burial apparatus that has been approved by popular undertakers. An electric alarm-clock was recently invented by a woman; also a fire-escape device, a brake for vehicles, a fruit-press, a carpet stretcher, an invalid-chair, a system of ventilating buildings, a barrel-tapping and emptying device, a hammer-guard for firearms, life-preservers, bottle-filling apparatus, and innumerable domestic appliances.

Trade-marks for patent medicines, complexion ointments, hair-restorers, soaps, and perfumes are also registered at the Patent Office by women in ever increasing numbers, and a fair proportion of these "specialty" goods inventors and makers have won fortunes either through their business shrewdness in putting their goods on the market, or because of the actual merit of the articles. Authorities agree that a greater number of women inventors have succeeded in the field of household appliances than in any other line; next come the inventors of toys, puzzles, children's games, and tricks such as are sold on the streets. Singular as it may seem, in the matter of small inventions for simplifying woman's wardrobe men have generally led the way, and even to-day men take out more patents of this nature than women do. On the other hand, women have been of marked assistance to men inventors in various mechanical lines of invention.—Olive F. Gunby, in New York Evening Post.

THE SAINT-CHAMOND COAST GUNS.

For coast defense, the modern howitzer is the gun par excellence. It can be fired while entirely concealed from the sight of the enemy, and can be put out of service only with difficulty. Moreover, as its projectiles are fired at a strong inclination, they are exceedingly dangerous, and are capable of reaching the deck of ships at wide angles and of sinking or at least of crippling the latter, or of putting them out of condition for fighting. A hostile squadron will never remain in quarters that are protected by such pieces. Howitzers therefore have the valuable property of being able to prevent an enemy from entering any roadstead that it might desire to occupy.

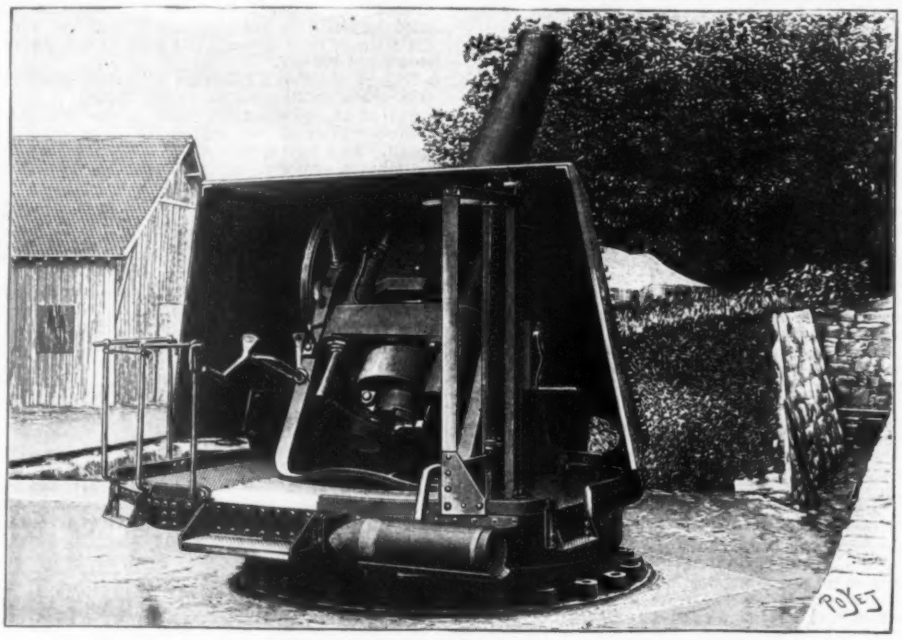


FIG. 2.—SAINT-CHAMOND COAST DEFENSE GUN OF 9.5-INCH CALIBER.

These pieces are of various calibers, which, however, do not exceed 10.75 inches. The one represented in Fig. 2 is of a caliber of 9.5 inches and was manufactured at the Saint Chamond Works after plans by MM. Darmancier and Dalzon. This gun, which is of steel, is constructed according to the system adopted by these engineers, and which is so well known that we shall not dwell upon it.

The projectile, which weighs 473 pounds, is charged simply with melinite, the destructive power of which is extraordinary.

The gun is destitute of trunnions, and, in its recoil or return to battery, slides in a jacket with slight friction. This jacket rests through trunnions upon a carriage supported by a bolster fixed upon a platform of concrete. The carriage and bolster are connected through a circle of conical rollers, and the bolster and platform by means of bolts. The bolster moves through a central pivot that traverses it. A catch in front of the carriage frame engages with the bolster and prevents the upsetting motion that the firing tends to produce.

FIG. 1.—SAINT-CHAMOND COAST DEFENSE GUN OF 8-INCH CALIBER.

All around the jacket are arranged cylinders for braking and returning to battery, two of each kind. These cylinders are so situated that those of the same kind shall be symmetrical with respect to the axis of the gun. In this way, the resultant of the stresses passes through this same axis, and the operation of the brakes can be no otherwise than satisfactory. The brakes are hydraulic and the recuperators are formed of metallic springs. The rods of the cylinders are operatively connected with the howitzer, being jointed to lugs carried by one of the hoops of the gun.

Owing to the conical rollers the gun and its carriage are capable of taking on a rotary motion of which the amplitude is one complete revolution, which is effected in two minutes. The upward pointing of the piece extends from —5 degrees to more than 60 degrees, and such total amplitude of 65 degrees can be traversed in seven seconds. These various displacements can be effected by one man acting upon hand-wheels arranged upon the sides of the frame. During firing the pointing remains invariable, since it is independent of the piece and participates neither in the recoil nor the return to battery.

The rear of the carriage frame is prolonged into a platform upon which the maneuvering and loading are done, and which revolves along with it. The projectile is brought mechanically opposite the breech aperture by means of a lift maneuvered by manual power. Owing to these various arrangements the service of the gun may be performed with great rapidity, and three shots be fired within the space of a minute.

In front of the gun is placed a shield of steel plate, which revolves along with it, and which is designed to protect the gunners and the material of the piece against projectiles fired by guns of medium or small caliber.

The same works have, in addition, constructed a coast gun of 8-inch caliber (Fig. 1) moving upon a central pivot. This piece, although of small caliber, is just as powerful as the one described above, by reason of the great velocity with which its projectile is fired. The frame is exactly the same as that of the 9.5-inch caliber gun, but, as the recoil is more violent here, the frame is provided with three catches instead of one.

The pointing is effected under the same conditions as before, and the loading also is done by the same means. The firing may be done at the rate of four shots a minute. The complete rotation of the gun upon the bolster takes but two minutes. The upward pointing, the amplitude of which extends from —7° to + 20°, can be effected in seven seconds.

The piece is provided with a nickel iron shield.—For the above particulars and the engravings we are indebted to La Nature.

CONTEMPORARY ELECTRICAL SCIENCE.*

IONS PRODUCED BY COLLISION.—J. S. Townsend has already described some researches which led him to the conclusion that negatively charged ions, moving through a gas, produce other ions, although the force acting on them is very small compared with the force necessary to produce the ordinary vacuum tube or spark discharges. He now gives a more complete account of these experiments, and shows that at low pressures the current may be considered to pass through three stages as the E.M.F. is increased. In the first stage, the current increases with the E.M.F.; in the second stage, the current remains practically constant and shows only small variations for comparatively large changes in the force; in the third stage, the current rapidly increases with the E.M.F. It is the negative ions which produce the large increases of conductivity. The velocity acquired by a negative ion in traveling freely between two points differing in potential by 4 volts is 10 times as great as its velocity of agitation at ordinary temperatures. The number of collisions made by an ion in going through a centimeter of air at 1mm. pressure is 21. At atmospheric pressure, each ion would produce some 10,000 other ions per centimeter, and the same number would be produced by a particle conveying "Becquerel rays."—J. S. Townsend, Phil. Mag., February, 1901.

SECONDARY RADIUM RAYS.—It is known that any substance placed in the neighborhood of a radium preparation becomes radio-active itself. Not only that,

*Compiled by E. E. Fournier d'Albe in The Electrician.

but it retains its radio-active powers for some time, which in the case of an actinium preparation may extend over several months. P. Curie and A. Debierne have recently made some experiments which shed much light on the manner in which this secondary radio-activity is induced. It appears that only the most easily absorbed rays enter into this phenomenon. They are absorbed by the air, and in the process of absorption they impart some property to the air which is diffused by convection, and eventually reaches the body exposed. That the process is not one of direct radiation is shown by the fact that if the preparation is separated from the body to be influenced by a long capillary tube bent at right angles the influence is exerted all the same. The maximum radio-activity is induced in a time which varies greatly with the amount of free space surrounding the radiant body. If it is a small space, the maximum is reached very soon. The authors do not attempt to frame a theory, but suspect a close connection between magnetic deviation and the absorption of rays.—Curie and Debierne, Comptes Rendus, March 4, 1901.

THE ELECTRIC EFFLUVIUM.—Under this somewhat antiquated name S. Leduc describes some further remarkable properties of the silent electric discharge whose physical and chemical effects he has latterly been investigating. He produces it by rapidly charging and discharging a condenser consisting of a metallic sphere on the one hand, and a sheet of aluminium with a central perforation on the other hand, separated by a plate of glass or celluloid. The central portion of the plate is on both its faces the origin of violet and ultra-violet rays, which can be concentrated by a quartz lens. These rays produce an intense fluorescence on a platino-cyanide screen without concentrating the beam. Photographic effects are obtained which surpass in intensity those produced by sunlight. The rays are particularly valuable for Finsen's treatment of anæmic tissues. These are compressed by means of a quartz plate contained in an ebonite frame, which directly adjoins the aluminium sheet forming one armature of the condenser. The diseased tissue is thus exposed to rays which have only to traverse a thin plate of quartz. The apparatus may be worked with an induction coil or an influence machine.—S. Leduc, Comptes Rendus, March 4, 1901.

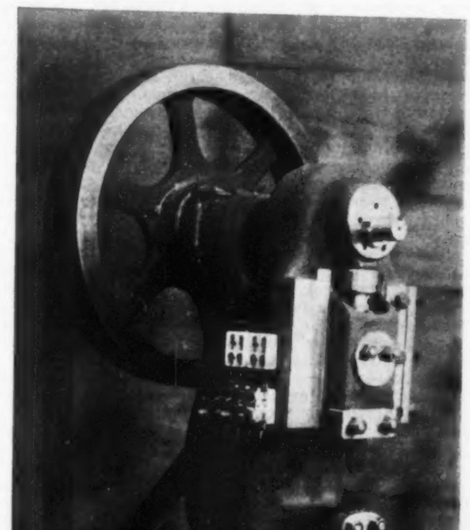
PROPAGATION OF ELECTRIC WAVES IN WATER.—When the electric and magnetic properties of an insulator only depend upon its dielectric constant, the wave-length of a resonator remains the same when measured first in air and then in the insulating medium in question. This proposition was deduced by Blondlot from considerations of homogeneity, and verified in the cases of castor oil and ice. If the medium is magnetic or conducting, or if it shows considerable absorption for electric waves, its properties are no longer completely defined by its dielectric constant, and the equality of wave-lengths of a resonator in air and in the medium cannot be certain. This is the case with ordinary spring water, which shows a decided conductivity and consequent absorption of electric waves. C. Gutton therefore measured the wave-lengths of a simple resonator in air and in water, and found that they were practically the same when resonator and wires were either out in the air or immersed in water. He also found that the path traversed by the waves during one period of the resonator oscillating in air is 8.3 times smaller in water than in air. This implies that when a resonator is plunged into water its period of oscillation becomes 8.3 greater than in air.—C. Gutton, Comptes Rendus, March 4, 1901.

MAGNETIC EFFECT ON DISCHARGES.—It is well known that if a discharge is passing through a tube containing rarefied gas, the effect of a transverse magnetic field is to increase the potential difference at the terminals and to diminish the current passing through it, while a longitudinal field renders the passage of the discharge easier. While working with tubes in which the pressure varied from 0.1mm. to 1mm., R. S. Willows noticed that under certain conditions the imposition of a transverse field caused a large increase in the current passing and a decrease in the potential difference of the terminals, just the opposite of what generally occurs. Further experiments showed that at a pressure of 1mm. the effect of the field was to diminish the current, but as the pressure was lowered this effect became less and less, until at a certain pressure no effect at all was produced on the current or the potential difference between the terminals, although the discharge itself was distorted. As the pressure was still further lowered the current was increased by putting on the magnetic field. The effect is probably due to some action of the electrodes, which has not yet been fully unraveled.—R. S. Willows, Phil. Mag., February, 1901.

VELOCITY OF FLAME IONS.—The new method suggested by J. J. Thomson for determining the velocity of ions in a gas not having hitherto been carried out, C. D. Child has applied it to the determination of the velocity of ions produced by a flame. The method consists in measuring the potential and the flow of current in a space through which only ions charged with one kind of electricity were passing. The main difficulty encountered in carrying the method into practice is that of accurately determining the potential at two points. A wire probe will not serve the purpose, as a positive charge will not leak off from it while a negative charge will. The author therefore employed the water dropper for this purpose. A gas flame was burnt between two metallic plates kept at a constant difference of potential by means of a water battery, and the water dropper was introduced between the flame and one of the plates. The results show that the velocity of the positive ions drawn from a Bunsen burner is approximately 2.2cm. per second for a potential gradient of 1 volt per centimeter, and that for negative ions 2.6cm. In the case of an unlimited supply of ions, if the discharge takes place between two regular surfaces, the velocity may be determined by simply measuring the current per unit area and the difference of potential between these surfaces, and if the surfaces are not at all regular, the relative velocities of the positive and negative ions may be determined by comparing the positive and negative currents.—C. D. Child, Phys. Review, February, 1901.

ELECTRICALLY OPERATED PUNCHING PRESSES.

THE managers of large manufacturing establishments are considering the use of electricity as a motive power for individual machines as a great advance over the methods heretofore used, and are rapidly introducing into their shops the latest types of machines electrically driven.



ELECTRICALLY OPERATED BELTED PUNCHING PRESS.

Among the leading manufacturers to introduce the electrically operated punching press are the E. W. Bliss Company, of Brooklyn and New York, and the Ferracute Machine Company, of Bridgeton, N. J. The accompanying illustrations show two types of geared and belted punching presses designed and constructed by the latter firm. The first shows a deep-throat press employed largely in the manufacture of sheet steel ranges, kitchen boilers, and similar work where holes have to be punched at a considerable distance from the edge of sheet. The weight of the wheel used is 250 pounds, and the speed of the wheel is from 100 to 150 revolutions per minute. The press weighs a trifle over a ton, and has a depth of throat of 24 inches.

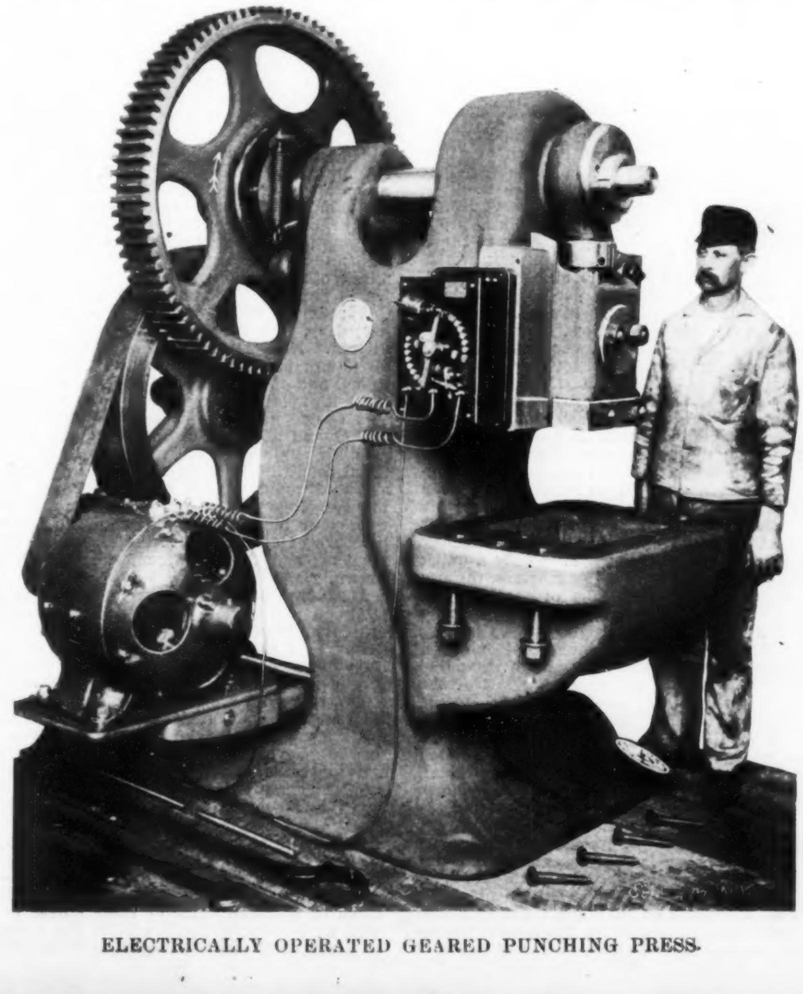
The geared type of punching presses shown in the large illustration are required if the material is as thick as the diameter of the hole punched and are preferable if the material is very hard or over half an inch thick in any case. They are also preferred for many other kinds of work requiring considerable power or a slow motion in forming work. The weight of this machine is something more than six tons, and it will be noted that the controller is automatic and within easy reach. For a lighter class of work an electrically driven punch is used. The shaft extends from front to back, and the flywheel is belt-driven from the motor at the rear. The flywheel weighs 750 pounds, and operates at 100 revolutions per minute, punching holes of 7-16 inch with 1-inch round dies.

The General Electric Company, of Schenectady, have demonstrated by the electrical equipment of their shops with machine tools driven by electric motors that they are not only very convenient, safe and cleanly, but are the most economical in every way. Their engineers make the comparison between mechanical and electrical transmission, assuming that a shop requires a delivery of power to machinery of 150 horse power, which is quite convincing. With a shafting transmission of energy of average efficiency (50 per cent) 300 horse power in engine capacity is required. With an electric transmission, each machine requiring 5 horse power or more may be driven by its own motor, and motors are available whose efficiency under average load is 85 per cent, or allowing a loss of 15 per cent. To deliver 150 horse power the motors must receive at their terminals 176 half horse power. The loss in the line can readily be kept below 5 per cent with a moderate cost of copper. This would require a generator capacity of 186 horse power to the line, which should have an efficiency at this output and at full load of at least 92 per cent, making a total loss from the pulley of the engine to the machine tool of 25 per cent, or an efficiency of transmission of 75 per cent. The required engine capacity would therefore be a trifle over 200 horse power, whereas the shafting transmission would need a 300 horse power engine to do the same work.

A NEW CONNECTION BETWEEN THE GRAVITY MEASURES OF EUROPE AND OF THE UNITED STATES.

ABSOLUTE measures of gravity, repeated by different observers using different instruments at identical stations, have shown comparatively large disagreements. The general experience has been that differential measures of gravity are much more accurate than absolute measures, and there has, therefore, been a growing tendency to use the differential method rather than the absolute method. The results of such differential measures may be reduced to absolute units either by connecting by the relative measures many stations at which absolute measures have been made and then making an adjustment to get a mean value, or a single determination of the absolute value of gravity, which is believed to be of a much higher degree of accuracy than any other, may be used in reduction to absolute units.

These general conditions, especially with respect to gravity stations in Europe and the United States, led naturally to the campaign of differential gravity meas-



ELECTRICALLY OPERATED GEARED PUNCHING PRESS.

ures carried out by Assistant G. R. Putnam, of the Coast and Geodetic Survey, in the summer of 1900, under the direction of the International Geodetic Association.

The compact and portable half-second differential pendulums known as A4, A5 and A6, and of the type developed under the direction of Dr. T. C. Mendenhall while he was superintendent of the Coast and Geodetic Survey, were swung at Washington in May and again in October, 1900. Between these dates they were also swung at the Kew University, Greenwich Observatory, London Polytechnic Institute, Paris Observatory and at Potsdam, Germany, and thus served to determine with considerable accuracy the relative values of gravity at these points. Some of the principal previous determinations of gravity which have been made at or near these stations, and are therefore connected by the observations of 1900, are at Washington, by Preston in 1889-90, and Defforges in 1893; at the Kew Observatory, by Heaviside in 1873-74, by Herschel in 1881-82, by Walker in 1888, by Von Sterneck in 1893; at Greenwich Observatory, by Von Sterneck in 1893; at the London Polytechnic Institute, by Sabine, Kater and Herschel; at the Paris Observatory, by Defforges in 1892, and Von Sterneck in 1893. At Potsdam the observations connect with a most elaborate and painstaking determination of the absolute value of gravity which is now in progress under the direction of the International Geodetic Association, and which is expected to yield the most reliable value ever yet determined in absolute units.

Other connections of varying degrees of accuracy had previously existed between these six stations. The new measures furnish direct connections of a very high degree of accuracy. These six stations have directly or indirectly been connected by various observations with nearly all the gravity stations of the world.

The work of deducing from the numerous connections between the gravity measures of various countries the best absolute values of gravity at the many points of observation scattered over the whole globe is peculiarly the duty of the International Geodetic Association, and is being performed systematically by that organization. In this investigation the gravity observations of 1900 furnish important new evidence.

The special value of these gravity measures of 1900 to the Coast and Geodetic Survey lies in the fact that they furnish the means of reducing accurately to absolute units all the relative measures made in the United States with the half-second pendulums during recent years. These values have up to the present time been reduced approximately to absolute units by assuming that the value of gravity at the Coast and Geodetic Survey Office is 980.098 dynes. This approximate value was adopted in 1892 and depends upon an absolute determination of gravity at Hoboken, N. J., and three comparisons of Hoboken with Washington by relative measures with three different sets of pendulums, and finally an absolute determination at Washington in 1889-90. In 1894 Mr. Putnam derived twenty-nine different values for gravity at Washington by utilizing all the connections available at that time between Washington and various stations at which absolute measures had been made by various observers from 1792 to date. The mean of these values was 980.107. As the individual determinations showed a wide range, 0.147, the value 980.098 cited above was retained. From the relative observations of 1900, combined with the preliminary published absolute value of gravity at Potsdam from the observations which are still in progress, the value of gravity at Washington is 980.111. This differs by one part in 77,000 from the approximate value adopted in 1892, and by only one part in 250,000 from the mean of the 29 values deduced in 1894.—John F. Hayford.

SOME PRACTICAL LABORATORY DEVICES.

By FRED'K T. GORDON.

THERE are a number of little devices employed in every laboratory that are very useful, both as time and labor savers; but—here comes the point—knowledge of these is seldom made public, and so they remain unknown or unthought of by the very people they would most benefit. The reason for this is probable because of the slight importance attached to these little helps by the user; he does not think it worth while even to sit down and write to his drug journal about them, and so make them of use to his fellow-druggists, or he thinks them of so little consequence that everybody must know them. Now, there are many young men just starting in business who would be only too glad to have such hints from experienced minds, and there are many, too, who are not gifted with a mechanical turn of mind and cannot improvise as well as a neighbor, and then again, one man may think of something and the other man of something else; all these would be benefited by mutual help in the way of laboratory hints and devices. In order to bring about a condition of mutual helpfulness, let me suggest that every druggist who is making use of some little device in his work sit down and write a description of it and send it to the Era, so that by an exchange of notes we may help and be helped. Never mind if it is only a quick way of filtering, a hint as to cleaning mortars, the use of waste material; all this will be of interest and value, and the column of the drug journal containing such matter will be almost the first to which the busy druggist will turn. Don't hide your light under a bushel; illuminate your brother's way with it, too!

As a start in this line, I will present a few of the little helps and devices that have been of use to me in my own work, and when I say I do not even know whether they are all new or all old I am but giving my strongest reason for suggesting the value of such an exchange of ideas. I do not claim them as original, for I don't know for sure but that others may have been using them all these many years; but such as they are I offer them to start others in this work.

MACERATION.—Maceration is a process still much used in making certain of our galenicals, and any device that will insure a saving of time with a thorough exhaustion of active principles will surely be of value. I have made an apparatus out of a quart fruit jar that serves me very well; the size of the "macerator" must, of course, be proportioned to the quantity of material operated on. Suspended about one-third down the jar is a piece of fine gauze made into the shape of a coffee strainer (bowl-shaped), which can be raised or lowered according to need by four wires running through holes bored in the top of the jar, which wires can be bent over to keep the gauze in place. To use this, the drug in powder is placed on top of the gauze, a piece of cheese cloth being first laid over this, and then moderately pressed down; then the gauze is lowered into the jar until the top portion of the drug is covered with the menstruum in the jar, the top is put on and the apparatus is set aside in a warm place. As the soluble portion of the drug is dissolved by the menstruum, this becomes heavier at the top, and the heavy portion sinks down and displaces a fresh supply, the action being automatic and continuous until the drug is exhausted or the menstruum saturated. If is sometimes necessary to put a second piece of gauze over the drug to prevent portions from floating to the top of the menstruum. In cases where gauze will not answer, a plate of tin perforated with small holes will do; the gist of the apparatus being the suspension of the drug at the top of the solvent instead of being at the bottom, so that no shaking is necessary to bring fresh portions of the solvent into contact with the drug to be exhausted. Saturated solutions of salts can also be quickly made by this plan.

PIPETTE DEVICE.—Anyone who has tried to suck up a caustic alkaline or acid solution through a pipette and had his lips burnt will appreciate the use of a bit of rubber tubing about six or eight inches long on the top of the pipette, with an ordinary burette clamp half-way down the rubber tube. By this device the fluid can be sucked up to the very top of the pipette without danger, and by releasing the clamp it can be retained there until withdrawn from the bottle. Then it is easy to adjust the fluid to the mark desired and to let out the quantity wanted by slight pressure on the clamp. Instead of a clamp, a valve can be made by inserting a bit of tight-fitting glass rod into the rubber tube; pressure on one side of the solid rod will make a little channel through which the liquid or air can flow; let go, and it closes immediately and prevents escape. This valve also is far ahead of a burette clamp in working with a burette; if rightly made, they never leak, and it is just as easy to let the reagent out by drops as in a fine stream, as the delivery is entirely under control by a slight pressure, a point not always possible when working with a clamp. For a burette, the rubber tube at the bottom need be but three or four inches long, the glass rod—or glass ball, as some prefer—is placed in the middle of the rubber tube. With a rubber tube and valve on pipette, they may be supported by clamps and used like a burette, the only difference being that the rubber tube and valve are at the top instead of at the bottom of the instrument.

BLOTTING PAPER.—I have found a good quality of thick blotting paper to be the best thing yet to put at the bottom of a percolator, on top of the cotton usually used as a filter. Cut your blotter about half an inch larger than the bottom of the percolator, then nick it around the sides half an inch deep; moisten it (to make it soft) and press it down on the cotton with a rod, the nicked sides folding in so as to make it fit snugly all around. Now pour in your drug to be percolated and pack it down as usual; you will not be troubled with a muddy fluid extract or tincture coming through, neither will your percolator be likely to become clogged up at the delivery end. A similar piece of blotter for the top of the drug is better than filter paper. Blotting paper, by the way, makes an admirable straining medium for thick liquids; fit disks of it in the bottom of a percolator and pour the liquid in and see how nicely it will filter through. For drying crystals, precipitates, etc., blotting paper has no superior.

WATER "AIR PUMP."—The druggist who is in the habit of using one of the ordinary "water air pumps" to hasten filtration is not apt to give it up in a hurry. A glass "air pump" can be bought for less than fifty cents, and can be attached to the spigot in a moment. Fit a good-sized fruit jar with an air-tight cork in which are bored a hole large enough for a fair-sized funnel, and a smaller hole for a bit of glass tube, to which latter is fitted a rubber tube connected with the air pump. To filter a thick liquid, put a good-sized wad of absorbent cotton in the bottom of your funnel, arranging it so that it will reach an inch or so up the sides; this is the support for your filter paper, which might otherwise break when the pressure inside the jar is reduced (blotting paper can also be used for this); fit the filter paper in snugly, moistening it if necessary, and fill the funnel with the liquid to be filtered. Now start the flow of water through your air pump; partial exhaustion of the air in the jar will ensue, and the pressure of the air on the liquid will force it rapidly through the filter. The whole cost of this device need not be over seventy-five cents—jar, funnel and all. An ordinary bicycle pump makes a good air pump when the valves are reversed, and in its usual condition is often of use in siphoning. Fit your siphon through a cork with two holes, put this into the bung-hole or top of the carboy, and pump in air with your bicycle pump through the other hole; the pressure of air will start the siphon to working in a moment, and the tube from the pump can be withdrawn.

ALCOHOL "BUNSEN BURNER."—There is an alcohol lamp on the market that gives as much heat as an ordinary Bunsen burner, with a smokeless flame at that. This works on the same principle as the gasoline "torch" used by plumbers, except that once started it needs no further attention. The alcohol is volatilized and mixes with the air as it escapes, giving a non-luminous flame of intense heat. In small towns, where gas is not available, this lamp is a boon in the laboratory whenever an intense heat is needed for a short time, it being possible to fuse ordinary glass tubing, melt lead, ignite precipitates, etc., with it. One of the small oil-stoves now sold under the name of "blue flame" is a mighty good thing for the country drug store in the absence of gas; it will do all the work of a gas burner without smoke, soot or smell—the great drawbacks of the ordinary oil stove—and can be used for a hundred and one different operations at the touch of a match. One of these stoves in connection with a "Remington" still will be the means of saving an amount of cash in the value of alcohol recovered that will astonish the druggist who throws away his percolates or just boils them down in open air. There are few drug stores that do not waste gallons of alcohol during the year (at $2.65 a gallon!) by evaporating down percolates in a dish or pan; all this could be saved by the use of a small still at a very small cost, and what is more, the druggist could make his own distilled water that he now buys, and lots of other "little" things that amount up in cost.

SCRAP BOOK.—It is a hobby of mine that no well-regulated drug store can be properly conducted without a scrap book in which are preserved recipes, notes of processes and appliances, news on new remedies, topics of value and articles on drugs, chemicals, etc., etc. Such a scrap book, properly and promptly indexed, is a mine of information to its possessor, and can easily be made from old ledgers or account books. There is a "letter book" on the market in which the leaves are about an inch or so wide and are gummed; these come in several sizes, and make an admirable form of scrap book. The way I make mine is to carefully cut the pages containing the matter I wish to preserve from the paper or journal, so as to leave the white margin at least ¾ inch wide, and then paste the leaves into the book by these margins. This gives the effect of a book, the leaves of which can be read on both sides. For smaller clippings, the best way is to paste them on the leaves of an old account book from which a number of pages have been removed, so that it will not be made too bulky by the clippings pasted in. The "letter books" mentioned make a good way for keeping price lists, "change sheets" (Era) and such like. A good plan in making up such a scrap book is to keep various topics separate; for instance, have part of the book devoted to urinalysis, another to recipes, another to general notes, and so on; then keep an index of this by entering the page on which a note is found whenever you paste one in. The great advantage of such a scrap book is that one has just the information he wants at hand, without having to look through a big pile of drug journals containing a lot of matter he does not want, and has it, too, in a compact form.

GENERAL NOTES.—I have found that a good way to prevent glass stoppers from becoming "stuck" in their bottles is to grease them well with vaseline or petrolatum, giving a few turns of the stopper to get a thin coat of petrolatum on the neck of the bottle, too. This also prevents "creeping" of sirups to a great extent, and makes an air-tight closing of the container possible. There need be no fear of the petrolatum dissolving or being affected by the ordinary contents of drug store bottles. I have even successfully used it on bottles holding strong acids and alkalies. Cheap and efficient crucibles for igniting a precipitate or for various operations can be made from the bowl of an ordinary clay pipe. Break off the stem close to the bowl and fill up the hole with a bit of plaster of paris paste. An atomizer is a fine appliance for furnishing a current of air to dry a precipitate or to evaporate an excess of alcohol, ether and such like solvents. I have evaporated a cubic centimeter of ether a minute with an atomizer from a small evaporating dish placed in a water bath, and now use this method altogether in evaporating off the solvent in alkaloidal assays in recovering the dissolved alkaloid. A good and efficient sieve can be made from cheap wire gauze and four strips of wood (2 inches wide) mortised together at the corners. By keeping on hand gauze of different sizes of mesh and cheese cloth, sieves of the desired size can be made very quickly and cheaply when wanted, using the same frame for all, the gauze being secured to it by being bent up and held in place with a few tacks. I find that steam radiators make a good evaporating and drying apparatus, the heat usually being quite regular and not high enough to spoil vegetable extracts.—Pharmaceutical Era.

WHY WE HAVE THE BALANCE OF TRADE.

"WHAT has caused so much produce, merchandise and specie of the United States to go out of the country without the ordinary corresponding return?" is the question recently propounded to the Treasury Bureau of Statistics by Mr. Dadabahai Naoroji, an Indian gentleman residing in London.

Mr. Naoroji in his inquiry addressed to the Bureau of Statistics quotes the recent figures showing a large excess of exports of merchandise and specie over the net imports of merchandise and specie, and says: "In India a heavy net excess always takes place because the system of government in India compels a heavy tribute, i. e., compels a large drain of the produce of India to England without any material return of merchandise or specie. But America is not under such a draining system of an alien foreign government; and I therefore desire to know the causes, and their extents, of such heavy net excess of exports of America's wealth or produce, and how this large 'balance of trade' is expected to be settled."

The following is an extract from the reply of the Chief of the Bureau of Statistics:

During the period immediately following our civil war great internal development of our railways and manufacturing occurred. Much foreign capital was brought into the United States for use in this development, and during that time and in subsequent years railroad and other securities were largely marketed abroad. The commercial results of this development of railways and manufacturing establishments, including the opening of new fields of production, was an enormous increase in the exportations and a disposition to relatively increase the importations, because the development of manufacturing was making it practicable to produce at home from our own materials much which was formerly brought in from abroad. Thus the great business development of the years 1870 to 1890 had a tendency to stimulate production and exportation, but discouraged importation, and, as a consequence, exports exceeded imports in a constantly increasing ratio. The fact, however, that large sums had been borrowed abroad for the internal developments above alluded to required payments of large sums for the annual interest charges, and thus absorbed a part of the proceeds of the surplus exports. The earnings of foreign capital invested in great enterprises in this country, other than that obtained by

the sale of bonds or by direct loans, also required considerable sums for the payment of the dividends and profits of the enterprises in which it was invested. The further fact that internal commerce and investments in internal developments were extremely profitable, reduced and temporarily suspended shipbuilding in the United States, and, as a consequence, the increasing traffic came to be carried more and more in foreign ships, and the payment of the freights thereon, especially the freights upon imports, again absorbed a large additional amount of the proceeds of the excess of exports.

Another factor to be considered is that of the money expended by Americans traveling abroad, who usually take their funds in the form of letters of credit, and draw from time to time for such sums as they require, and this, of course, proves an offset to that extent against the balance which would otherwise be returned to the United States in the form of cash.

Until recently these four great factors—(1) the payment of interest on American securities held abroad; (2) the payment of earnings of foreign capital invested in business enterprises in the United States; (3) the payment of foreign freights carried in foreign vessels, especially freights on goods imported into the United States; and (4) the expenditures of Americans traveling abroad, have been considered the chief cause of the fact that the exports of merchandise so much exceeded the combined imports of merchandise, specie and bullion. Within the last two or three years, however, three further factors have apparently been added—(1) the cancellation of American indebtedness abroad, including a return to the United States of the railroad and other securities thus held; (2) the sale of foreign securities in the United States, such as the German, British and Russian securities, which were placed upon the markets here during the last year, and in most cases quickly taken, to the amount of probably $100,000,000 in the year; and (3) the credits which now stand abroad in favor of our exporters, and which are permitted to so stand because better interest rates could thus be realized than by insisting upon their immediate payment.

The sums of money represented by these various factors, which presumably about equal the excess of exports over imports, have been variously estimated, and up to the present time no means of obtaining more than estimates have been devised. These estimates usually put the amount paid to foreign vessels as freight on imports at about $50,000,000; interest on and earnings of foreign capital, $75,000,000 to $100,000,000; money expended abroad by Americans, $75,000,000 to $100,000,000; American funds invested in foreign securities in 1900, about $100,000,000; and credits permitted to stand abroad in 1899 and 1900, each $75,000,000 to $100,000,000; to which must be added the amount of our foreign indebtedness actually canceled by the return of securities for which no definite estimate has, so far as I am aware, been made.

The United States is rapidly increasing her production, especially of the minerals and of manufactures for exportation, while the rapid development of our manufacturing industries steadily reduces the relative importations of manufactured goods, though the raw materials required for our manufactures, especially those of a tropical and sub-tropical nature, which we cannot produce at home, are constantly increasing, as are also the tropical foodstuffs, of which we do not produce a sufficient quantity to meet our own requirements. The fact that we are rapidly becoming a creditor instead of a debtor nation will reduce to a minimum and wipe out the annual balance for payment of interest on our securities held abroad, and finally for the liquidation of those securities, and to this extent the absorption of our favorable balance of trade will be rapidly reduced; while the present disposition to encourage the re-establishment of our shipping industry in a sufficient volume to carry our growing commerce seems to justify the expectation that this drain upon our surplus may be at least somewhat reduced in the near future. Our foreign credits, as above alluded to, have increased largely during the last few years, and foreign obligations have been taken by investors in the United States in large sums; but it seems at least probable that two of the factors which absorbed a considerable share of the favorable balance, viz., the payment of interest and indebtedness abroad and payment of freights to foreign vessels, will within a comparatively short time be materially reduced, and thus require a settlement with specie and bullion of a larger proportion of the trade balance than has been the case in former years.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

American vs. Welsh Coal.—Consul Caughy, of Messina, says that Messrs. Peirce & Becker, of that city, recently received an inquiry from England as to the quality of Pocahontas coal. The English company, the letter stated, noted that the Messina firm had been discharging a cargo of this coal and asked a candid opinion as to how it compared with Welsh. The answer reads, in part:

We are not prepared to state what percentage of small a cargo of Pocahontas will show after discharging, but it will be perceptibly greater than in the case of a cargo of good screened Welsh coal. But the small of Pocahontas is more serviceable than that of Welsh coal, excepting, perhaps, the limited number of first-class brands of Welsh small, although we are not even sure about this, as Pocahontas small cakes wonderfully well and is very clean.

We have been using Pocahontas for years for our own steamers, which, we should add, have Howden's forced draft, and consequently fire-bars rather close together.

We should call it, taking it all around, fully equal to the very best Cardiff coal that we have ever had the opportunity of using, and we should say that on several occasions we have specially laid ourselves out to get the very best Cardiff coal, without sticking at the price, as we are convinced that the best coal is the cheapest in the long run. But we have found Welsh coal to vary considerably, the price and the brand being an unreliable guaranty as to quality and results; while Pocahontas coal, although it is only run of mine and not screened, is constant and practically always the same quality.

For our part, we consider it to be, on the whole, a stronger and cleaner coal than such Welsh, even of the higher-priced brands, as is accessible to the general public.

New Railway Brake in Belgium.—The department in charge of the Belgian Government railways, as well as the independent companies of this and adjoining countries, contemplate the general improvement of train service. They propose to change the compartment to vestibule cars as soon as possible and to have them heated according to the most improved methods. Much attention is to be given to the speed and regularity of the train service. I translate the following from the Journal de Bruxelles:

Experiments are being made with a new brake for railway trains, which would reduce the running time more than one-third at a speed of 80 kilometers (49.7 miles) per hour.

It is known as the Luyers system, and consists principally in a friction pulley fastened to the axle, on which the shoes act, permitting a quick stop with remarkable smoothness.

Satisfactory trials were made last year with a car on the Ghent-Terneuzen Railway Company's lines, and the Minister of Railways authorized the placing of friction pulleys on ten 15-ton cars provided with Westinghouse brakes, to serve as the final test. This took place at Setzaete, in the presence of engineers representing the principal railway companies of France, Germany, the Netherlands, and Spain.

The result was favorable at all rates of speed. With the tire brake now in use, a train at a speed of 81 kilometers (50.3 miles) per hour may be stopped within 290 meters (990 feet) in twenty-five seconds, while the Luyers brake can stop a train at the same speed in a distance of only 171 meters (438 feet) under the same conditions of adhesion and pressure, and in less than sixteen seconds.—Alfred A. Winslow, Consul at Liege.

Utilization of Sugar-Beet Waste.—In a recent report on the advance of the sugar-beet industry in the United States in 1899, the question of utilizing the beet heads and leaves which remain after harvest is treated as follows:

"All who have any experience with them readily concede their nutritive value. If free from dirt, they would be an available addition to the list of silo plants, yet I cannot help feeling that the ones who have given this subject most attention are right when they assert that these leaves are more valuable left on the ground in the fields as a fertilizer, inasmuch as they contain exactly the right elements that the soil needs, and in available form."

This judgment is now only partly true, says Mr. Ernest Anders, of Magdeburg, an acknowledged expert on sugar beets, since the chief reason has been discovered why the nutritive qualities (which, as we know by chemical analysis, are contained in the tops and leaves of the beet) have not been used to their greatest extent, and since this knowledge has roused the desire to seek for means to remedy this defect.

The chief reasons which prevent the rational utilizing of these agricultural by-products as stock food are the fact that they become mixed with earth and dirt, the impossibility of using more than a part of the by-products as fodder while they are still fresh (the greater part being spoilt by the influence of the weather), and, further, the tremendous loss of matter—often one-third of the whole mass—which results from the fermentation in silos.

The principal cause, however, is that the fresh leaves contain a poisonous matter. This is oxalic acid and its combination with potassium and sodium. The dry matter contains from 4 to 6 per cent of this poisonous substance, and even the fermented leaves contain from 2 to 3 per cent. The first effect of this poison upon an animal which has been fed with fresh leaves is to produce severe purgation, and a continued use of the fermented leaves produces fractures of the bones. This last symptom is caused by the solubility of the oxalic acid. The easily soluble combinations of oxalic acid with potassium and sodium, as they are found in the beet leaves, are poisonous, but, on the contrary, the combination of oxalic acid with calcium (oxalate of lime) is but slightly, if at all, poisonous, because it is insoluble and therefore leaves the body. Should the food contain an insufficient quantity of lime, the deficiency must be supplied from that contained in the body of the animal itself, from the phosphate of lime which gives strength to the bones. This makes the bones of the animal poorer in lime and fragile. This has been demonstrated by Prof. Dr. Zuntz in the animal physiological laboratory of the School of Agriculture at Berlin. An attempt has been made to render the oxalic salts harmless by adding carbonate of lime to the food, or by scattering it among the leaves when storing them in silos, if possible in the form of precipitates obtained from the beet-sugar factories.

This, however, is to be recommended only in cases of necessity, as it raises the already high percentage of earthy impurities in the fresh as well as in the fermented leaves, and a satisfactory solution of this problem must therefore be sought elsewhere.

After many unsuccessful attempts, a German farmer named Wuestenhagen—part owner of the sugar factory Hecklingen, near Stassfurt, in this district—has succeeded in making an easily digestible food from the heads of the beet, together with the stems and leaves which are cut off at the harvest, by the following process: (1) Cleansing of the leaves from earth and dirt; (2) almost complete destruction of the oxalic acid contained in the leaves; (3) conservation of sugar contained in the heads; (4) slicing of the entire material; and, finally, (5) drying and storing of the same. Each of these five points is equally important. The discovery is patented.

The tops and leaves are left on the field about ten days to wither, during which time they lose from 80 to 85 per cent of the water they contain. At the same time, the leaves shrink together very much, so that when they are loaded on the wagon and well shaken by the workmen, a great part of the earth falls off. The material is then put into a revolving drum supplied with sieves, into which hot air streams. This dries the particles of earth and sand and almost all fall through the sieve.

These proceedings are followed by an almost complete decomposition of the oxalic acid, which interesting fact has been discovered by Prof. Dr. Maercker, of Halle.

The temperature of the hot air must not rise beyond a certain point, in order that the heads of the beet may not lose any of their sugar contents. The material which has been in this way half dried is then cut up into slices, and the drying is completed at a lower temperature.

This sequence in the order of proceeding is very important. The heads and the leafy parts of the beet have a totally different construction from the surface of the leaves. If one attempted to dry the material without cutting it into slices, the leaves would be burned while the insides of the stems and the heads were still damp. If one were to cut the material into slices without drying it, the sticky mass which would result would be most difficult to dry.

The half-dried material must also be cut so that there can be no loss of the material during the removal of the impurities, which continues throughout the drying process.

Prof. Maercker, who is known far outside of Germany as one of the best authorities in agricultural questions, says in a report that the dry material resulting from this process is a food with an admirable appearance; that it is composed of good substances and can be preserved a long time; that it has a healthy smell and a correspondingly bright color, which shows that the temperature during the process of drying has not been high enough to cause the decomposition of the sugar. It contains 14 per cent and more of sugar, while the percentage of oxalic acid has been reduced to 0.42 per cent. If one assumes that an acre of beets produces 6,000 kilogrammes (13,200 pounds) of by-products, the gain in dry food would be about 1,500 kilogrammes (3,300 pounds) per acre.

The firm of Buettner & Meyer, of Uedingen-on-the-Rhine, has also patented a system for drying the leaves, which is said to be somewhat different from that of Wuestenhagen.

It is presumed that in both systems the drying apparatus is used in connection with the sugar factory. Such an apparatus, with all the necessary accessories for drying the leaves and beet tops produced on an area of from 600 to 1,000 acres, would hardly be obtainable for less than 20,000 marks ($5,000).

As the supply of leaves and heads comes at the same time as the supply of the beet, farms at some distance from the sugar factory would gain little advantage from such an arrangement, on account of the high costs of transport. It has therefore been proposed to erect small apparatus of this kind at railway stations or at some other place conveniently situated for a certain number of farms. Apparatus which could easily be transported would be the best for this purpose.

It is of the first importance to have a knowledge of the high value as food of the beat and its by-products, whether on the field in the form of leaves and heads or in the factory after the sugar has been extracted, especially in the form of molasses and pulp.

Only when the farmers of the United States pay more attention to this question than has hitherto been the case, can the beet-sugar industry be properly developed with us. To give an impulse in this direction is the object of this report.—Max J. Baehr, Consul at Magdeburg.

Import Duties in Colombia.—Minister Hart transmits from Bogotá, under date of March 12, 1901, translation of a decree of the Colombian Executive exempting from import duties certain food products. The decree says:

The following articles are declared exempt from import duties in the custom-houses of the Republic during the continuance of the present disturbed condition of the public order and during sixty days more: Sweet potatoes, potatoes, onions, garlic, rice, corn, pease, lentils, beans, sugar, wheat flour, lard, butter, and all kinds of vegetables; grains and garden stuffs imported in their natural state and without any preparation whatever. The decree takes effect from the date of its publication (March 5).

Electric Plants in Dutch East India.—Under date of March 29, 1901, Consul Hill, of Amsterdam, informs the Department that Messrs. H. R. der Mosch and H. Jul Joostenz, of Batavia, Java, have been granted a thirty-year concession for the erection of electric light and power plants in the cities of Padang and Djokjakarta. Padang, says the consul, is the largest city of the west coast of Sumatra and has a population of about 35,000. Djokjakarta contains 85,000 people and may be reached by rail from Samarang.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Cement for Glass.—Le Practicien Industriel gives the following formula: Mix 8 parts of finely powdered colophony and 4 parts of English red; add 2 parts of white wax and melt, adding only one part of turpentine. Stir well, but avoid contact with the fire, even of any portion running over.

An Illumination Equal to Daylight is obtained by causing electric arc light to pass through a blue light-filter of copper sulphate possessing a slight thickness. This enables one to produce an illumination which admits, like daylight, of the examination and judging of colored textile samples, etc., while other artificial sources of light illuminate differently. There is, for instance, a color which is green in daylight, but appears reddish-brown in gas light.—Die Werkstatt.

Blacking Powder for Shoemakers.—

Green vitriol, calcined and powdered	30.0 parts
Logwood extract, powdered	4.0 parts
Potato starch, powdered	4.0 parts
Butzbach brilliant black	2.0 parts
Oxalic acid, technical, powdered	1.5 parts
Yellow potassium chromate, pow'd.	0.6 part
Brilliant black B	0.6 part

The raw materials are well intermixed by sifting and put up in paper bags containing 100 grammes, 10 of these bags being packed in a collapsible cardboard package. The contents of a bag dissolved in a liter of boiling water gives an excellent black and polishing ink for the edges of soles and heels.—Revue über die Harz-, Fett- und Oelindustrie.

A Highly Adhesive Paste for Leather is prepared as follows, according to Schuh und Leder: Soak 4 parts by weight of good glue in 15 parts of cold water and heat moderately till the solution turns perfectly clear. Then add, with constant stirring, 65 parts of boiling water. In another vessel stir 30 parts of starch with 20 parts of cold water, so that a milky liquid without lumps results. Into this the boiling glue is gradually stirred, the whole being kept for a short time in the boiling state. After it has cooled, a few drops of carbolic acid are added to the paste, which possesses great adhesive qualities and is useful for leather, paper, cardboard covers, etc. It is kept in corked bottles and does not spoil for years.

Production of Platinum.—During the last years the production of platinum—which metal, owing to its high melting point, is esteemed especially as a material for crucibles and incandescent wires—amounted to 4,800 to 5,100 kilos. As the demand last year exceeded the production, which was about 4,950 kilos, the price has advanced considerably. Russia must be regarded as the chief source of this valuable material, more than 90 per cent of the above total production having been furnished by that country. The production of Russia in 1900, for example, amounted to no less than 4,590 kilos. The price of platinum has risen within the period of about seven years from 1,800 marks to 2,600 marks ($430 to $620) per kilo.—Edelmetal Industrie.

Luminous Lead.—A fresh important contribution to the knowledge of the remarkable luminous rays emitted by certain minerals which were first discovered in pitch-blende by the Parisian chemist Becquerel has been made by the German savants Hoffmann and Strauss in the Berichte der Deutschen Chemischen Gesellschaft. They have extracted from various minerals, as pitch-blende, cleveite, broeggerite, copper-uranite, samarskite and exenite, a body which entirely resembles lead in its chemical properties. It is like the latter precipitated from an acid solution by hydrogen sulphide, and its compound with iodine possesses a yellow color. It differs from lead only in the striking phenomenon that it acts in complete darkness upon the photographic plate and emits a light which creates a line in the violet portion of the spectrum. This line differs in its position from that caused by glowing lead in the spectrum, and for this reason the two investigators assume that there must be another as yet unknown element in the body whose atomic weight must be above 260.

Deodorization of Petroleum.—As a rule, the various attempts to deodorize refined petroleum were not made for the purpose of improving the oil used for illuminating purposes, for the processes are too costly for that. The main object has probably been to produce an oil as indifferent as possible, which may, without revealing its origin, be employed for dissolving other essential or unctuous oils. Particularly in Italy endeavors have been made to obtain such an oil suitable for being mixed with or adulterating the oils manufactured there by expressing the fruit peels of various varieties of oranges and lemons.

The following are some receipts for the deodorization:

1. Agitate 4 liters of petroleum with 100 grammes of zinc chloride and pour the mixture into a vessel containing burnt lime. After mixing well, allow to settle and decant the petroleum.

2. To a mixture of sulphuric acid 0.25 liter, water 1.75 liters and potassium permanganate 30 grammes add 4½ liters of benzine and mix well. Next allow to settle for 24 hours and diligently shake the skimmed-off benzine with a solution of potassium permanganate 7.5 grammes and soda 15 grammes in 1 liter of water.

3. The Revue de Chimie contains an article by Charles Henry, according to which inodorous petroleum is obtained by mixing 100 kilos of petroleum with litharge 1½ kilos, potash 9 kilos and water 20 kilos. The dark color of this petroleum is due to the presence of either light or heavy hydrocarbons. In the former case Henry uses ozone for bleaching the petroleum. Where heavy hydrocarbons are present or for such oils as are darkened by the action of light, this method is not available, since it would make them still darker. In this case he treats the petroleum with reducing agents, such as zinc dust, sodium hyposulphite or stannic chloride. Filtering with bone charcoal is likewise said to give good results. In order to reduce expenses, the charcoal may be cleaned again with acetone and thus recovered for further use.—Uhland's Technische Rundschau, through Seifensieder Zeitung.

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TABLE OF CONTENTS.